INTERMOUNTAIN STATION
Central Reference File
No. 0,73

U. S. DEPARTMENT OF AGRICULTURE

Forest Service

Investigative Report

ANNUAL REPORT OF

INTERMOUNTAIN FOREST & RANGE EXPERIMENT STATION

FOR 1938

Ogden, Utah

REPORT FOR THE CALENDAR YEAR 1938

INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION

TABLE OF CONTENTS

	Page
PREFACE	1
RANGE ECONOMICS RESEARCH (New division)	5
PROJECT STATUS SHEETS	
Forest	17
Range	23
Influences	51
APPENDIX	
Publications	61
Personnel	67

R - INT
Investigative Program
and Report

March 15, 1939

REPORT OF THE INTERMOUNTAIN FOREST AND RANGE EXPERIMENT STATION FOR THE CALENDAR YEAR 1938

* * * * * *

PREFACE

The region served by the Intermountain Forest and Range Experiment Station includes Utah, Nevada, Idaho south of the Salmon River, and western Wyoming, comprising an area of approximately 180 million acres, of which 96 percent is forest and range and only 3 percent cultivated land. Of the total wild land area, 11 percent is classed as timber land, part of which is grazed; 75 percent is strictly grazing land, while 85 percent of the total is used by livestock. These wild lands are intimately and fundamentally related to the social and economic well-being of the inhabitants of the region. The range livestock industry contributes directly approximately one-half of the agricultural income of the region, and indirectly contributes much to the other half. The forests supply timber for lumber and ties, poles and posts for mines and farms, and fuel for a large rural population.

Agriculture, which is the basic industry in the region, has developed under a system of irrigation and depends almost entirely upon water that is yielded from the forest and range lands. Recreation and wildlife have become, during the last two decades, increasingly important and demands for the extension of these uses are creating conflict among different population groups, which is intensifying the conservation problems. Use of wild land resources -- forage, timber, water and recreation -- has made possible the economic and social development of the region, and the perpetuity of this development depends upon their continued use.

Wild land management then becomes a function in which every citizen in the region should be vitally interested. It should not be the concern of the stockman and the timber operator only, but of every rural and city dweller, for, even more than those directly using the resource, are more vulnerable to disaster if the forest and range resources are destructively used. The problems confronting the administrators of the range and timber lands are obviously not limited to the requirements of forage for livestock or to the demands for products of the forest. Increased and multiple use demands have carried the problems far beyond simple forage and timber production into complexities arising from the need to conserve usable stream flow, provide fish, game, and recreation for thousands of people, and above all to conserve the soil on which these assets either directly or indirectly depend.

In a program of resource conservation soil stability must be the goal of attainment. All use must be adjusted to this requirement, and standards for utilization must be founded upon basic principles underlying soil formation and stability. Failure to recognize this has given rise to most of the serious resource ills of the region. Depleted range lands, on which there is no erosion, present only a problem of improving and maintaining vegetative cover, but on watersheds where improper use and fire have resulted in excessive loss of plant cover and accelerated soil erosion there exists the complicated problem of soil stabilization and building in addition to reestablishment of plant cover. The range lands of the Intermountain region have been especially susceptible to soil deterioration. Had utilization of these lands during the past half century been such as to have maintained reasonable plant cover conditions, thereby preventing accelerated erosion of the soil, most of the problems of range management currently plaguing us would never have developed.

Range management today finds itself in grips with many problems which have grown out of improper management and use. It has to deal with something much broader and more vital than mere forage production for livestock; it must understand and function on the basis of the complex relationships of utilization to soil stability, stream flow, siltation, and floods. Failure to function on this basis will simply result in further aggravation of accelerated erosion and concomitant phenomena of floods, siltation of reservoirs and canals, reduction in forage resource, and the destruction of age-old soil. Unfortunately, range utilization without accelerated erosion calls for knowledge which did not exist in pioneer days and which even now, after years of experience and research, is still so incomplete as to yield only partial solution to many of our range problems.

One solution for watershed protection and soil erosion prevention would be to eliminate grazing, which to the sentimental conservationist, has a strong appeal. Such a solution though apparently simple smacks of defeatism and would have disastrous consequences, for the range livestock industry of the West is vital to the economic and social welfare of the country, and cries loudly for the continued use of the vast area of non-agricultural lands. Of necessity, a solution must proceed along the major premise that forage can be harvested from most of the so-called range lands and yet provide for full protection of the regimen of streams, for prevention of abnormal floods and siltation, all without impairment of the soil resource.

In any solution full cognizance must be taken of the two major problems -- rehabilitation of depleted and eroding ranges, and maintenance through proper management measures of those areas considered to be in a satisfactory state of productivity. The second may be easier than the first, for reconstruction is always a difficult undertaking, and with our injured and broken ranges we face not only the physical and biological problems of the range itself but the social and economic problems that are associated with man's use of that range. Furthermore, for social and economic reasons, utilization must go on simultaneously with rehabilitation. It is necessary for us "to live in the house" while we repair and reconstruct it.

The ultimate solution of the range-erosion problems is dependent on how quickly and thoroughly the specific details of management and rehabilitation can be worked out and how completely they will be incorporated into the schemes of utilization of the forage resource. It is easy to understand why proper range utilization has not always been practiced and why a satisfactory program requires so much effort when we realize the complex physical and biological conditions that make up a western range. It is the complexity of these conditions which has made the consequences of past activities so easy to overlook, so difficult to foresee. Climate and topography are so diverse that most of the range region can be classed as "high hazard." Steep slopes, torrential storms, widely fluctuating amounts of precipitation in desert and semi-arid climates, shallow, easily eroded soil, and a natural sparsity of protective plant cover characterize much of the range.

But irrespective of the nature or condition of the range, the pressure of the economic demand for the full utilization of the forage resource is as great today as it ever was. Here then is the problem of grazing these lands and yet conserving their watershed and recreational values. It is one to challenge our best efforts. Surely it justifies an aggressive program of research and management that will repair the losses already incurred, secure the permanency of the grazing industry and protect the agricultural, industrial, and community values dependent on the wild lands of the region.

The research program of the Intermountain Station, although limited in scope, has been organized to furnish facts upon which a program of wild land use could be built that will assure the preservation of the soil, forage, timber, water, recreation, and wildlife values.

Accomplishments of the several divisions in our research organization -- forest management, range investigations, influences, economics -- during the past year have been satisfactory, and especially gratifying has been the extent to which the findings of our investigations into the problems of plant cover restoration, soil stabilization, and flood control have been adopted and applied by the administrative branch of the Forest Service and other government agencies. A program of rehabilitation on critical watersheds in the region through the application of upstream engineering, reseeding, planting, and improved management practices has been greatly expanded and will be extended to new fronts this summer. This action program has made special demands of research for basic principles and techniques upon which to build a program and upon our personnel for help in planning and inspection work.

The application of research methods and results to the analysis of flood and erosion problems and to rehabilitation of critical watersheds has been sufficiently successful to accomplish wide public recognition and professional acceptance. Certain sectors of the public have expressed their conviction in the validity of the plant-soil-water relationship concept by their greatly increased attendance at field days and demonstrations, by requests for information, and by demands that certain eroding and flood producing watersheds be added to the national forests.

As a result of this awakened interest a number of additions comprising watershed areas have been made to the national forests in recent years and plans are now under way for extending the acquisition program. Also, in certain critical areas where acquisition by the national forests has been delayed or was impossible of attainment, cities, villages, and counties have purchased watershed lands and donated them to the national forests so that work of waterflow retardation and erosion control could be undertaken with the assurance of continued protection.

Our last two annual reports reviewed the progress of research in the Intermountain region from the initiation of investigations at the Great Basin Experiment Station to the present expanded program of the Intermountain Forest and Range Experiment Station. We presented also the more outstanding results of our current research with an interpretation of their application to regional problems. In addition to this, special sections were prepared by the three divisions of the station, Range Management, Forest Management, and Influences, in which the wild land problems were set forth and analyzed, the extent to which our research program was designed to meet these problems, and the needs for the future.

This year we are limiting our special discussion to problems of range economic research which have been prepared by the division of Range Economics recently organized at this station. Work in this division is being conducted in cooperation with the national forest administration, the Utah State Agricultural Experiment Station, the Bureau of Agricultural Economics, and the Nevada Agricultural Experiment Station.

ECONOMIC AND SOCIAL POLICIES AND PROBLEMS IN THE USE OF THE RANGE RESOURCE OF THE INTERMOUNTAIN REGION

THE EVOLUTION OF PUBLIC LAND POLICY

A land policy for the management and use of timber and range lands in permanent public ownership had its inception in this nation with the reservation of national forests from the public domain. Since that time a set of public land policies has been developed, the broad aspects of which now are (1) conservation of the resource, (2) multiple use of the resource, (3) wide distribution of the benefits of use, and (4) recognition of the need of change in use in keeping with changing social needs.

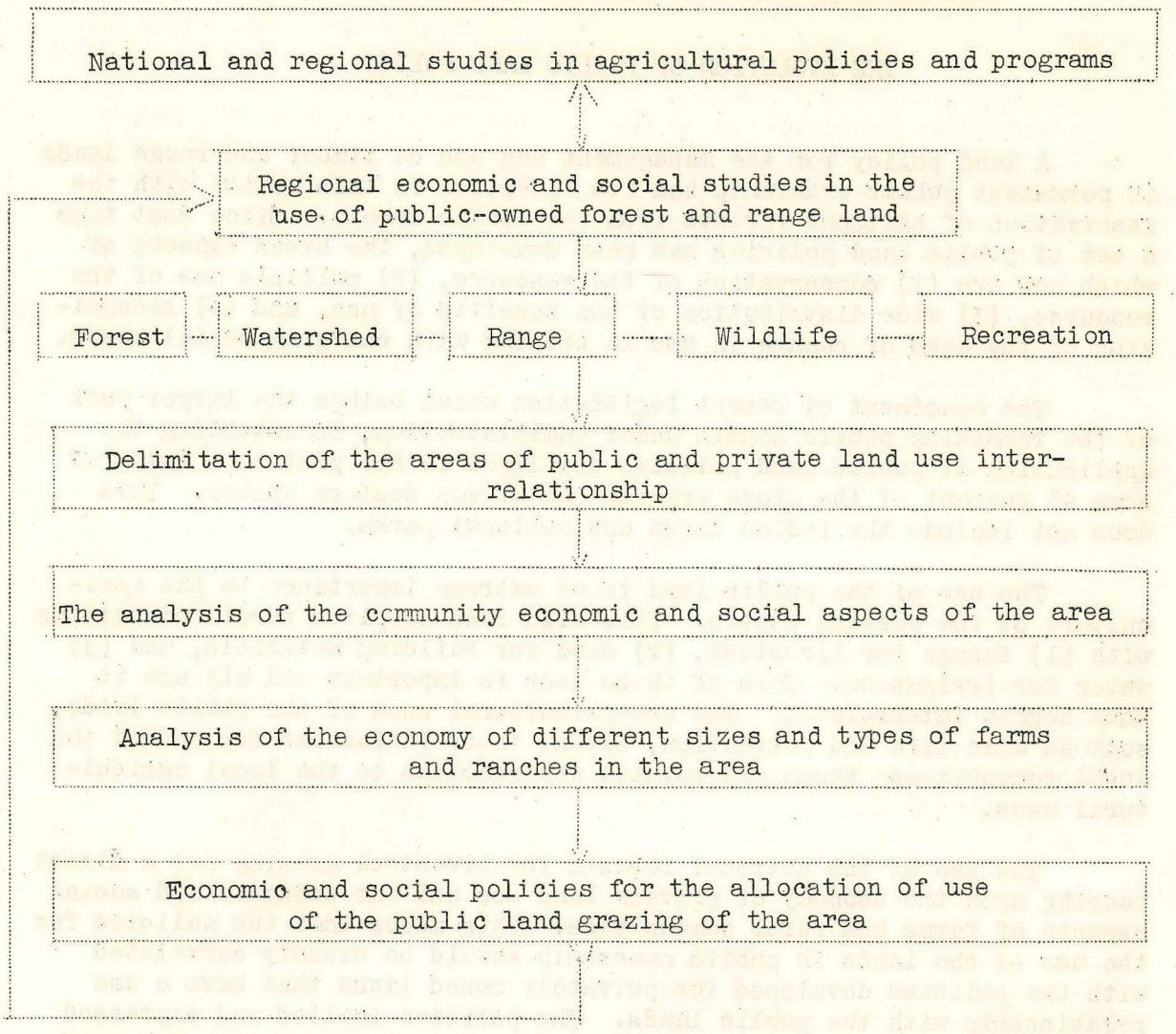
The enactment of recent legislation which brings the larger part of the remaining public domain under administration, is extending the application of public land policies developed in the past to a total of some 40 percent of the gross area of the eleven western states. This does not include the Indian lands and national parks.

The use of the public land is of extreme importance to the agriculture of the western states. This wild land supplies rural communities with (1) forage for livestock, (2) wood for building materials, and (3) water for irrigation. Each of these uses is important and all are in some degree interrelated. The nonagricultural uses of the public lands, such as wild life and recreation, extend their influences far beyond the local communities; these are related nevertheless to the local agricultural uses.

The use of the national forests for livestock grazing has a direct bearing upon the economy of private land use and the economic and social aspects of farms and rural communities. This means that the policies for the use of the lands in public ownership should be closely correlated with the policies developed for privately owned lands that have a use relationship with the public lands. The policies implied and expressed in legislation and administration with reference to the privately owned lands are, principally; (1) land resource conservation, (2) production adjustments for improving farm and ranch income, (3) land use adjustments for improving incomes and lowering rural social costs, and (4) facilitating operator ownership of family-sized units.

These land policies are being implemented through programs for (1) public acquisition and administration of lands, (2) cooperation between the Federal Government and the individual, (3) cooperation between groups of individuals, (4) application of the land use regulatory powers of the states, and (5) public educational measures.

It is partly because of this use relationship of the public lands to private lands that studies of the economic and social aspects of the public lands are a part of the broader fields of national agricultural policy and land policy. Such studies should be oriented with and designed to make a contribution to the evolution of a national land policy. The following diagram illustrates this concept:


National and regional studies in agricultural policies and programs
Regional economic and social studies in the use of public-owned forest and range land
Forest
Watershed
Range
Wildlife
Recreation
Delimitation of the areas of public and private land use inter-relationship
The analysis of the community economic and social aspects of the area
Analysis of the economy of different sizes and types of farms and ranches in the area
Economic and social policies for the allocation of use of the public land grazing of the area

This diagram is not intended to be complete. National and regional studies in agricultural policies and programs cover much more than the use of the public lands, and economic and social studies of the uses of the public lands must encompass more than the range use. The study of the range use is, however, a logical starting point for economic analysis of the use of the public lands in the Intermountain region. The range use is of direct economic and social consequence to many of the people engaged in agriculture and is closely related to other important uses, such as the watershed use. It become obvious that an area approach for economic studies is desirable; the area defined in terms of a geographic complementary use relationship which prevails between the public and the private lands.

THE ECONOMIC AND SOCIAL PROBLEMS IN THE USE OF THE PUBLIC LANDS FOR GRAZING IN THE INTERMOUNTAIN REGION

Adjustments in the use of the public land range resource concerns a high proportion of the farm and ranch operators in the Intermountain region

The use of the public lands of the Intermountain region for livestock production is important both in quantity of feed they produce and in the seasonal character of the use. This region has in the past maintained 12 to 15 percent of the sheep numbers of the United States. The significance of public land grazing in this region is evident from the following data showing the livestock numbers and public land grazing:

Table 1.- Farms and ranches, and livestock numbers in the Intermountain region (1935 Census)

	Total no. of all farms and ranches	Farms & ranches with cattle	Total no. of all cattle	No. of beef cattle	Farms & ranches with sheep	No. of sheep
Idaho*	36,800	32,700	722,300	545,000	8,500	2,193,000
Utah	30,700	24,200	411,000	310,000	6,400	2,452,000
Nevada	3,700	2,900	342,000	322,000	900	835,000
Wyoming*	4,400	3,500	200,100	181,100	1,500	977,400
Region total	75,600	63,300	1,675,400	1,358,100	17,300	6,457,400

* Includes only the part of the state in U. S. Forest Service, Region 4.

Table 2.- Public land grazing permits in U. S. Forest Service Region 4 (1937 data)

	Cattle permits on national forests	Cattle on national forests	Sheep permits on national forests	Sheep on national forests	Total permits on grazing districts	Sheep on grazing districts	Cattle on grazing districts
	Number	Number	Number	Number	Number	Number	Number
Idaho	2,021	105,400	809	951,295	3,600	1,840,000	207,000
Utah	4,482	111,146	1,764	697,955	5,200	1,922,000	173,000
Nevada	294	52,632	122	263,105	1,240	1,266,000	269,000
Wyoming	466	44,822	226	307,045	570	536,300	70,400
Region total	7,263	314,000	2,921	2,219,400	10,610	5,634,300	719,400

These data show for the region that approximately one-fourth of the beef cattle and one-third of the sheep graze on the national forests; that over one-half of the beef cattle and about 90 percent of the sheep are maintained for a part of the year on the grazing districts. The national forests are grazed principally during the summer months, the grazing districts during the winter, while the private lands furnish primarily winter, spring, and autumn feed.

The allocation of the grazing privileges on the public lands determines the use and value of much of the private land

What is the significance of this regional picture of public land use which concerns a high percentage of the livestock numbers and nearly one-third of all the farms and ranches? This means that the policies for the use of the public land grazing resource determine the character of the use of much of the privately owned ranch land, influence the economy of farms, and modify the economic and social aspects of rural communities. There may be general agreement on the policies in the use of the public lands, and at the same time be some serious question on the methods by which these policies may be effectively realized.

The administrators of the national forests, in attempting to attain the most beneficial distribution of the use of the public land range resource, must seek the answers to such questions as:

1. What is the relative economic dependency (a) of different kinds of privately owned land for a grazing use on the public land, (b) of different types of farms and ranches upon public land grazing, and (c) of different communities for the use of the public land?

2. What is an "economic-sized" family farm or ranch unit for the different communities and areas that are associated with the use of the public lands?

3. Can a substantial number of the "subeconomic" sized farm and ranch units of a community be improved through public land grazing preference adjustment?

The problem of allocating the use of the public land range to the livestock enterprises of different sizes and types in a manner that will contribute most effectively to a prosperous and stable rural economy requires an analysis of present permit distribution in relation to total number and size classes of livestock enterprises. These data are summarized in tables 3, 4, and 5. They give a picture, by states, of the extent to which the different sized livestock enterprises are now permitted on the national forest range.

Many farm-flock sheep operations now using the national forest range may realize higher incomes by operating yearlong on the farm

Data on ownership size classes for sheep show that approximately one-sixth of all of the farms of Utah and of Idaho have a farm flock sheep enterprise of a size varying from a few head up to 300 head. These farm flock owners have about 19 percent of the Idaho sheep numbers and 17 percent of the Utah sheep numbers. Many of these farm flocks are now making use of the national forest range.

There is need for an economic analysis of the alternatives in operation which are available to the owner of the farm flock, such as operating yearlong on the farm, or running his flock in a cooperative band upon the forest. There are indications that in certain communities the farm flock sheep enterprises are now too small for effective use of the outside range, and that a farm flock enterprise may yield a much higher labor return if kept on the farm yearlong and managed for early lamb production. There apparently are, however, certain farm communities adjacent to the national forest where the farm flock sheep operations make as high a use of the range from the purely economic standpoint as do the specialized stock ranches, resulting in a substantial contribution to the income of a large number of small farms.

A high percentage of the large farm flock and small range band ownerships in the 300-to 1,000-size class now have a grazing permit on the national forests of Region 4. The indications are that these operations are concentrated in the areas of a more extensive type of farming and ranching rather than in the areas of irrigated specialty crop production. Empirical information indicates that these sheep operations have a relatively high economic dependency upon the national forest range.

The question of a "monopoly" use of national forest range by large operators

The data contained in tables 3, 4, and 5 show that the sheep ownerships in the three size classes, 1 to 100, 101 to 300, and 300 to 1,000, account for one-third of the sheep numbers of Utah, but are getting about 60 percent of the sheep grazing on the national forests in Utah. Contrasted with this, the range sheep operators of Nevada who are

Table 3.- Idaho - Size classes of sheep permits on the national forests and of sheep enterprises on all farms and ranches

Size class No. of sheep	Forest permits		Census farms and ranches		Percent of enterprises with forest permits	Census farms and ranches	
	No.	Percent of total	No. of enterprises	Percent of total		Number of sheep	Percent of total
1 - 100	139	15.0	5,013	72.9	2.8	320,224	9.9
101 - 300	181	20.5	994	14.4	18.2	299,459	9.2
301 - 1,000	278	30.5	434	6.3	64.0	401,659	12.4
1,001 - 2,500	214	23.5	272	3.9	78.7	637,363	19.7
2,501 - 5,000	77	8.5	90	1.3	85.5	416,900	12.9
5,001 -10,000	24	1.5	49	.7	48.9	469,929	14.5
10,000 & over	3	.5	28	.4	10.7	694,391	21.4
Totals	916	100	6,880	100	13.3	3,239,925	100

Table 4.- Utah - Size class of sheep permits on the national forests and of sheep enterprises on all farms & ranches

Size class No. of sheep	Forest permits		Census farms and ranches		Percent of enterprises with forest permits	Census farms and ranches	
	No.	Percent of total	No. of enterprises	Percent of total		Number of sheep	Percent of total
1 - 100	630	34	3,423	56.1	18.4	186,678	6.6
101 - 300	584	31	1,191	19.5	49.0	286,172	10.2
301 - 1,000	424	23.6	841	13.7	50.45	551,980	19.6
1,000-2,500	213	11	457	7.5	46.6	803,514	28.6
2,501-5,000	9	.5	158	2.6	5.7	568,976	20.3
5,001-10,000	1		29	.5	.3	210,832	7.5
10,000 or over	0		7	.1	0.0	201,272	7.2
Totals	1,861	100	6,106	100	30.5	2,809,424	100

Table 5.- Nevada - Size classes of sheep permits on the national forests & of sheep enterprises on all farms and ranches

Size class No. of sheep	Forest permits		Census farms and ranches		Percent of enterprises with forest permits	Census farms and ranches	
	No.	Percent of total	No. of enterprises	Percent of total		Number of sheep	Percent of total
1-100	0		367	48.3	0.0	20,861	1.8
101-300	8	7	97	12.8	8.2	27,469	2.3
301-1,000	27	25.5	71	9.3	38.0	37,529	3.2
1,001-2,500	46	42.0	121	15.9	38.0	267,667	22.8
2,501-5,000	19	17.5	53	7.0	35.8	232,630	19.9
5,001-10,000	5	4.5	36	4.7	13.9	300,278	25.6
10,000 & over	4	3.5	15	2.0	26.6	284,981	24.3
Totals	109	100	760	100	14.3	1,171,415	100

in the ownership size classes above 2,500 sheep own 70 percent of the sheep of Nevada and have about 80 percent of the sheep use on the national forests of Nevada. There are state-wide figures which, if broken down by national forests and other areas, will show greater extremes.

A high percentage of the Idaho sheep ownerships in the 1,000-to 2,500-and the 2,500-to 5,000-size classes have permits on the national forests of Idaho. This may be in keeping with the optimum economic size that is attainable for a high percentage of the family-owned and operated sheep ranches under the Idaho conditions. There are, however, localities where much of the public land range resource is used by operations above these size classes. These areas may have a type and a geography of range resource that cannot be operated economically by either the family-sized ranches or the farming communities.

In an inquiry of "monopolistic" use of the national forest range by the large livestock ownerships, a comparison of the present ratio between the number of forest permits and the total number of sheep owners in the different size groups is significant.

The data in table 6 show that for the size classes above 300 head, which account for a very high percentage of total sheep permits and sheep numbers, there is a close relationship between the ratio of the number of forest permittees to the total number of sheep owners in these size groups. The exceptions are the 300-to 1,000-size class of Utah, which has a higher percentage of the total number of permits than of owners, the 2,500-to 5,000-class of Utah, which has a relatively low share of the forest permits, and the 5,000-to 10,000-class of Nevada, which accounts for 12 percent of the number of owners, and but 4 percent of the number of national forest permits. The percentage of national forest grazing privileges occurring in different sizes of sheep enterprises is about the same as the percentage of all the enterprises, both permittee and nonpermittee, in the different size classes.

Table 6.- Comparison of the percentages of all sheep enterprises and of national forest permits in the size classes above 300 head (for Idaho, Utah, and Nevada)

Size class	Idaho				Utah				Nevada			
	Permits		Enterprises		Permits		Enterprises		Permits		Enterprises	
no. of sheep	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
300-1,000	278	46	434	50	424	65	841	56	27	27	71	24
1,001-2,500	214	36	272	32	213	33	457	31	46	45	121	41
2,501-5,000	77	13	90	10	9	2	158	10.5	19	19	53	18
5,001-10,000	24	4	49	5	1	0	29	2	5	5	36	12
10,001 & over	3	1	28	3	0	0	7	.5	4	4	15	5
Totals	596	100	873	100	647	100	1492	100	101	100	296	100

The problem of competition between the farm herds and the specialized stock ranches for the use of the national forest cattle ranges

The Region 4 national forest cattle permit data contained in table 7 shows a high percentage of the permits in the 1-to 20-size class. Most of these small permits are the farm herds, and the permit, in the typical case, is equal to one-half or two-thirds of the number of cattle owned by the permittee. The farm enterprise of beef cattle smaller than 20 head may be of questionable economic efficiency in the use of the range. There are, however, some communities of small farms close to the national forests where the small farm herd of beef or dual purpose cattle makes and important contribution to the incomes of the small diversified farms. But an economic analysis of these farms and of the farm herd enterprises may show other and better alternatives for the farms, and point the way to an improved use and management of the national forest range resource. The available information indicates heavy losses and low production for the small farm herds while on the range.

It may be noted in table 7 that the permits in the 100-to 600-size range are in the minority in all of the states in the region. Those size classes of permits will account for most of the cattle ownership in the 200-to 1,000-size range which western ranch studies have pointed to most frequently as the optimum economic size limits for the efficient operation of a specialized stock ranch.

Table 7.- Size classes of cattle permits on the national forests by states - Region 4

Size class no. of cattle	Permits in each size class							
	Idaho		Utah		Wyoming		Nevada	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
1-20	1,237	49.4	2,369	59.1	95	35.4	20	7.3
21-40	583	23.3	1,059	26.4	35	13.1	30	10.9
41-100	468	18.7	478	11.9	49	18.3	77	28.0
101-200	148	5.9	80	2.0	47	17.5	59	21.5
201-600	68	2.7	19	.5	31	11.6	70	25.5
601-1,000	2	.08	2	.05	9	3.4	13	4.7
1,001 & over	-	-	1	.02	2	.7	6	2.1
Totals	2,506	100	4,008	100	268	100	275	100

THE RESEARCH APPROACH TO THE PROBLEMS

The analysis of land use relationships is based upon the area associations between the farm and ranch communities and the public land resource

In an economic analysis of the interrelationship between the farms and ranches and the public lands, the "area" may be a national forest and the related farm and ranch communities, and other public lands. Or the area may be a "type of farming" area recognized to be economically related to the use of different divisions of more than one of the national forests.

It is necessary at the outset, therefore, to develop a concept for the region of the land use areas that are associated with the public lands. A background of "inventory" information is essential for a description of these areas. The best available background information for use in depicting areas would include:

1. The type of farming studies of the Bureau of Agricultural Economics, which give a geographic picture of resources, land use, farm types, and the pattern of agricultural production.

2. Soils and forest and range survey information which give a general picture of the type, productivity, and season of use of the range resource.

3. The trail routes and movements of livestock between the public lands and the farms and ranches.

4. The maps and statistical picture of national forest and grazing district permits, by the forests and the districts and their subdivisions.

Certain areas must be selected as representing different phases of the problem

The description of areas needs to be of such a nature that it points to the important differences in the economy of areas and the relation of the use of the public land to agriculture.

The methods and the consequence of adjustment for conservation of the range resource may be the most important economic and social considerations for some areas. The economy of the extremes of small and large grazing permits on the public lands may be the important phase of economic analysis in another area. The economy of public land use by certain of the prevailing types of farms and ranches may be the important aspect of the problem for an area. The relation between the capitalization of values on the privately owned range lands and the charge for the use of the public lands might conceivably be the important subject for economic inquiry in one of the areas.

The background of inventory material upon which the concept of land use areas is based, supplemented by empirical information, indicates the regional significance of certain aspects of the problem and the area or areas in which work should be undertaken.

The procedure in the analysis of an area

For an area selected for study data showing the location of farms and ranches, the crop acreage, the total acreage, the livestock numbers, and the gross income probability would be developed for all farms and ranches, both permittee and nonpermittee, and the data mapped "in place" show the land use and community pattern of the area. This permittee and nonpermittee farm and ranch data would be summarized to show for the area and its community subdivisions the number of the permittee and the nonpermittee "farms" in each of the principal types. These types would include:

1. Diversified farms with and without a livestock enterprise (cattle or sheep).

2. Farms for which livestock is the main enterprise.

3. Stock ranches.

A statistical picture of the size (in terms of income) would be then developed for all of the operating units in the land use area. The farm management aspect of enterprise relationships and costs is then studied for a limited number of each of the types and sizes of operating units. The purpose of this procedure is to rate the different types and sizes of farms and ranches on:

1. Their alternatives, other than range livestock, for the use of their land.

2. Their relative possibilities for operating a livestock enterprise without the use of the public land.

3. Their relative economic efficiencies in the use of the public land for livestock production.

4. Their relative needs for the range privilege in attaining the (possible) desirable income standards.

This analysis then could be used as the basis for developing a rating for the different type and size of operating units into classes of dependency upon the use of the range.

A LOOK AT THE FUTURE

The problems and questions raised in the preceding paragraphs are not academic. They are live and vital issues in the use and administration of the western public lands. Choice must be made in the alternatives for the use of the public land range resource because it is

limited in relation to the present demands and needs for it. The present pattern of use will not be necessarily the best one for the future because present values will tend to realign in response to changing economic and social forces. Regional shifts in livestock population as a result of interregional competition will alter present land use relationships. The present relationship between livestock, wildlife, and land conservation will result in changes in future use of the public lands.

The area economic and social analysis interpreted against the background of regional and national economic and social trends will afford this necessary evolution of principles and policies in the future administration of the range resource.

This investigative approach is one that requires an evaluation and application of the results of other research, and must be closely correlated with certain phases of the investigative programs of the Bureau of Agricultural Economics and the State Agricultural Experiment Stations.

The time requirements of this approach are such that the present resources of the Station will mean the completion of only one area study a year. The procedures and the principles that are developed in the study may be applied to the study area and extended to other similar areas by national forest administration, through a cooperative arrangement with the State Extension Services.

The eventual objective of the research program in forest and range land economics should be to work on correlated area land policy for all of the multiple uses of the public lands of each area studied. The work on the economics of range use of the public lands is only a starting point. Eventually the work must comprehend the economic and social relationships of all of the important public land uses.

FOREST MANAGEMENT

RS - INT
M-1

March 15, 1939

HARVEST CUTTINGS (PONDEROSA PINE)

1. Field division: Forest management research.

2. Work project: Silviculture.

3. Line project: Harvest cuttings.

4. Purpose: To determine the most satisfactory methods of cutting ponderosa pine in order not only (1) to insure reserve stands of minimum mortality and waste, maximum growth and quality; (2) to promote natural regeneration; and (3) to provide for sustained production of lumber and other products, but also (4) to safeguard the watershed functions of timber lands.

5. Review of past work: (1) The principal line of work has been the measurement of actual results of various methods of cutting on permanent sample plots established for this purpose. Information on growth, mortality, reproduction, and logging damage has been derived and reported for three such plots on the Payette National Forest, one on the Salmon National Forest, and seven on the Boise National Forest. (2) An extensive survey of five selectively cut areas in central Idaho in 1932-34 has shown on a broader basis the results in terms of growth, etc., of past Forest Service cuttings and provided data useful in planning future cuttings and guiding more intensive cutting studies. (3) The Boise Basin Experimental Forest was established in 1933 to serve as a small demonstration unit of sustained yield operation and a testing area for various cutting methods and logging practices; aside from sanitation and hazard reduction, there have been no cuttings since 1933 when five marking methods were applied on seven plots. (4) Supplementary to cut-over plots, growth of virgin ponderosa pine stands has been measured on 13 permanent sample plots since 1913 and on 1 plot on the Boise Experimental Forest established in 1935. (5) Four periodic surveys (1934-38) of the experimental forest have been made to determine mortality from barkbeetle attack -- a question of major importance in this type.

6. Accomplishments during past year: (1) Full remeasurement of seven major plots and examination of reproduction transects; no compilation yet. (2) The barkbeetle survey of 1938 indicated a loss of 127 trees or 132,802 board feet on 2,182 acres of virgin pine type. This is equivalent to 0.5 percent of the total volume of the stand. The number of trees killed is slightly greater than in 1937 but volume loss is 16 percent lower. Corresponding loss of Douglas fir is 51 percent lower than in 1937.

7. Plans for next year: (1) Compile remeasurement data particularly on reproduction phases. (2) Check transects. (3) Complete report on extensive cut-over study. (4) Annual barkbeetle survey.

8. Date of completion: 1, 2, and 4 - indefinite; 3 - complete in 1939.

9. Assignment: T. E. Maki and E. L. Mowat.

RS - INT
Mt

March 15, 1939

STAND IMPROVEMENT (PONDEROSA PINE)

1. Field division: Forest management research.

2. Work project: Silviculture.

3. Line project: Stand improvement.

4. Purpose: To evolve and test methods of stand improvement which are silviculturally and economically feasible in the ponderosa pine type.

5. Review of past work: (1) In 1934 twenty-five plots representing five degrees of thinning were established in sapling and pole stands. To date these have indicated that snow damage in the first two winters following treatment is appreciable but not serious. (2) In 1934, '35, '36, and '37, establishment of small demonstration areas in 30- to 60-year-old stands has shown that crop tree thinnings will yield up to 11 cords of fuel wood per acre and still leave a residual stand of over 100 trees including 40 to 50 choice well-spaced crop trees. (3) Pruning studies have indicated the type of tree economical to prune, and the type of tool suitable to use. (4) Yearly removal of dead and dying trees on the experimental forest by free use, administrative use, and sales at cost procedure has served to supply the village of Idaho City (pop. 200) with the bulk of its fuel wood needs and has also served materially as a sanitation and a fire hazard reduction measure despite the handicap of an inadequate utilization road system.

6. Accomplishments during past year: (1) Considerable progress was made in analysis of pruning study data. (2) Sanitation and hazard reduction cuttings on experimental forest continued. (3) Pruning of the second log (i.e. from 17 feet to 33 feet) on trees which had received a previous pruning of the butt log (0 to 17 feet) show that a combination of ladder and Tarzan methods appeared suitable for the purpose.

7. Plans for next year: (1) Five-year remeasurement of 25 sapling and pole thinning plots. (2) Completion of analyses and reports on previous pruning studies.

8. Date of completion: Indefinite.

9. Assignment: T. E. Maki.

RS - INT
M-1, R
(B-Phenology)

March 15, 1939

SILVICS (PONDEROSA PINE)

1. Field division: Forest management research.

2. Work project: Silviculture.

3. Line project: Silvics (ponderosa pine).

4. Purpose: The silvical studies in ponderosa pine deal with one major subject, natural regeneration; and one minor subject, forest phenology. The regeneration study aims to determine factors and conditions affecting natural reproduction through all stages, involving: (1) seed supply and distribution, (2) physical and biotic factors pertaining to germination and seedling establishment, and (3) factors pertaining to subsequent survival and growth. Purpose of phenology study is to determine time of seasonal growth and other phenological events, to relate these to climatic data, and to use this information in other investigations and in forest management.

5. Review of past work: Regeneration factors: Cone crop records of 1,500 trees on permanent sample plots for past 5 years and seed trap studies have given useful data on seed production and distribution, showing adequate base supply in good seed years. During 1936-37-38 the factors affecting seed germination and seedling establishment were measured on a series of seeded plots in exclosures on north, south, and flat sites. Extensive transect studies (in addition to those on Mc plots) in 1935 and 1937 to determine effects of soil, aspect, cover, etc., upon establishment and first year mortality of natural seedlings. Phenology: On the Boise Basin Experimental Forest weekly measurements of current diameter and height growth of local tree species made through growing seasons of 1936-37-38; phenological notes and growth measurements on key species of grasses, herbs, and shrubs.

6. Accomplishments during past year: Regeneration: Work on all of above phases continued, field work of intensive physical factor study with seeded plots completed, analysis incomplete. Seed crop of 1938 very light, as was that of 1937. New study of relations of plant competition, shade, and aspect to seedling establishment (involving seedling observations and physical factor measurements on a series of 96 paired plots in 3 vegetational types) showed germination little affected by plant competition, but mortality much higher and vigor and growth poorer under competition. Phenology: Observations continued on schedule.

7. Plans for next year: Regeneration factors: Seed supply measurements to be continued, and further mortality and growth to be determined for "special study" seedlings on transects. Competition study to be continued with additional seedings to determine seasonal differences. Compilation and analysis of all data to be brought up-to-date. Phenology: Data to be analyzed and correlated with weather records and results of interest reported, observations to be continued on similar scale.

8. Date of completion: Regeneration factors: mostly by 1940, with minor phases on to 1944 or beyond. Phenology - indefinite.

9. Assignment: E. L. Mowat.

RS - INT
Fp

March 15, 1939

FIELD PLANTING AND SEEDING (PONDEROSA PINE)

1. Field division: Forest management research.

2. Work project: Regeneration.

3. Line project: Planting.

4. Purpose: To determine (1) the factors of site and of source, size, age, and treatment of stock, and (2) the methods of planting and seeding responsible for good and poor survival and growth in order to develop (a) planting and seeding techniques, and (b) criteria of site selection which will insure satisfactory regeneration of burned-over or otherwise denuded timber lands in the Intermountain region.

5. Review of past work: (1) Experimental plantings since 1934 and yearly seedings since 1935 have indicated the gross stock, site, planting method, and biology problems that need to be solved before satisfactory regeneration is attained. Use of husky stock, with long roots, planting in deep holes, and reducing competition have indicated promise in planting; hardware cloth cones of 1/3-inch mesh, and reduction in competing vegetation have shown to advantage in seeding. (2) Studies in the Bannock Creek Experimental Nursery established in 1936 have indicated desirable forms of seedbed protection, watering schedules, thinning practices. (3) Studies of root systems of both planted and natural seedlings have shown the need for revising concepts concerning adaptability of ordinary fibrous-rooted severely pruned ponderosa pine in central Idaho granitic soils. (4) Studies of seed have furnished a reliable seed maturity index, and indicated desirable collection and storage practices.

6. Accomplishments during the past year: (1) An experiment involving five methods of planting and three grades of stock was installed. (2) An intensive study of artificial seeding and a comparison of seeding and planting were initiated. (3) Reports on (a) methods of determining seed maturity in ponderosa pine; (b) artificial seeding, and (c) planting practice in the Intermountain region were prepared. (4) A root pruner designed to cut roots at various depths down to 15 inches, (even in relatively compact granitic loam soils) was tested in the experimental nursery and found to operate satisfactorily. The use of long taproot stock would make deep power pruning in the nursery necessary.

7. Plans for next year: (1) Spring and fall seedings and plantings in seasonal and yearly factor experiments. (2) Examination of previous plantations and seedings as per annual schedules. (3) Completion of report on ponderosa pine seed.

8. Date of Completion: Indefinite.

9. Assignment: T. E. Maki and E. L. Mowat.

RANGE MANAGEMENT

RR - INT
Management
Utilization Standards March 15, 1939

UTILIZATION STANDARDS FOR RANGE FORAGE PLANTS

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Utilization standards: determination of standards of satisfactory forage utilization on western ranges.

4. Purpose: This work limited primarily to summer range types is to determine (1) the proper degree of utilization for range forage plants; (2) suitable standards for judging the degree of utilization; and (3) the proper intensities of use for the various vegetational types.

5. Review of past work: Early work by Sampson and other workers (USDA Bull. 1405) and range men led to the general conclusion that if 10 to 25 percent of the herbage of the more palatable species was left at the close of the grazing season proper utilization had been attained. A sheep grazing study on forage utilization was concluded in 1929 and a cattle experiment in 1932. Analysis has been made of the data and progress reports prepared. In 1938 a new project was initiated at the Great Basin Branch Station for further study of this phase of work.

6. Accomplishments during past year: In cooperation with R-4 Range Management a tentative range utilization handbook, summarizing existing basic information on proper range use and setting up tentative utilization standards for the major range types was prepared and distributed to selected range men for review and checking in the field. These handbooks have been returned with comments and suggestions from field men and are being reviewed for purpose of making revisions in order to (1) standardize procedure in determining utilization, and (2) set up the most satisfactory standards of forage utilization for such range types as existing information permits.

   Wheatgrass plants fully utilized the previous year made only 68 percent as much growth as nearby plants which were ungrazed in 1937. Plants which were utilized about from 70 to 80 percent, and 35 to 50 percent, produced yields of 85 and 88 percent respectively of that from ungrazed plants. Mountain brome plants fully utilized and those utilized about 70 to 80 percent produced about 75 percent as much forage as ungrazed plants, whereas the series grazed to 35 to 50 percent produced 88 percent as much. Yields of hairy geranium utilized 35 to 50 percent were reduced about 11 percent in comparison with 22 percent from closely utilized.

7. Plans for next year: A better pasture set-up is needed to permit observation of degree of utilization of important range forage species along with grazing management studies. Clipping and physiological studies of mountain brome and Letterman needlegrass are planned.

8. Date of completion: Indefinite.

9. Assignment: Ira Clark.

RR - INT
Management
Summer Range

March 15, 1939

SUMMER RANGES: SUCCESSIONAL STATUS OF VEGETATIONAL TYPES

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Summer ranges; methods of managing high summer ranges in the mountainous regions of the West.

4. Purpose of work: To determine the relation of the structure of plant communities now occupying extensive range areas to their potential structure under proper grazing management, and the rate of successional change.

5. Review of past work: Results of early work on plant succession on the Wasatch Plateau have been reported in USDA Bulls. 791 (1919) and 1405 (1926). Studies on seed germination have been reported in Bot. Gaz. 98: 243-269, 1936 and a report has been submitted for publication covering other phases of seeding habits of native range plants.

6. Accomplishments during past year: Comprehensive analysis of quadrat, major plot, and permanent estimate plot data gathered over the past 15 years has been undertaken. Results to date include a rough rating of the principal forage species with regard to longevity, demonstration of slowness of recovery, even under protection, of greatly depleted range lacking a natural seed source, and demonstration of the high mortality of the seedlings of herbaceous plants. During the initial year the mortality of seedling is terrific. Only 6 to 13 percent of the seedlings of nine important species of herbs and grasses present in the spring of the second year survived to end of the fourth year. Grazing as it is practiced on the Manti Forest at present is evidently not the chief factor in the death of seedlings.

7. Plans for next year: Emphasis will be placed on analysis of natural revegetation data already collected, with special reference to life histories and interactions of forage species, nature of successional change, and rate of recovery of depleted range. Field observations will be continued at such a minimum as will just maintain continuity of the experiments. No new work of major character will be undertaken until analysis of past work is complete enough to permit efficient planning. The Great Basin Station herbarium, which is inadequate, will be built up by collecting during the coming field season.

8. Date of completion: Indefinite.

9. Assignment: George Stewart and Lincoln Ellison.

RR - INT
Management
Summer Range

March 15, 1939

SUMMER RANGES: CLIMATE, PLANT GROWTH AND FORAGE PRODUCTION

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Summer ranges: Methods of managing high summer ranges in the mountainous regions of the West.

4. Purpose: To determine relative influence of the various climatic factors on the rate of plant growth and amount of forage produced, the extent of variations in forage production which may be expected to occur, and adjustments of range management which may be necessary to conform with such variations.

5. Review of past work: Results of short-term studies prior to 1923 were published as USDA Bull. 1405. Climatic records which have been maintained in three major vegetational zones of the Wasatch Plateau in Utah since 1914 indicate extreme fluctuations in climatic conditions which, by affecting the amount and quality of forage, thereby affect the beginning and ending dates of the grazing season. Phenological observations of important range species since 1925 have shown that range readiness may vary as much as 47 days in the same vegetational zone. A climatic summary for four stations on the west front of the Wasatch Plateau for the 20-year period, 1914-34, published in the Monthly Weather Review 65: 291-301, 1937, described the nature and variation in such climatic factors as precipitation, soil moisture, and soil and air temperature.

6. Accomplishments during past year: A manuscript, "Climate and Plant Growth in Relation to Range Management," on the basis of 10-year phenological and climatic studies at the Great Basin Station, was brought to completion. It describes the delay in plant development with increase in altitude (roughly, 12 days for each 1,000 feet), variations in growth rate at different elevations, variations in date of appearance of the most important developmental stages (20 to 100 days), correlation of temperature and precipitation with rate of growth, and of date of snow disappearance with date of vegetative readiness. The 10-year averages give a basis for judging current range conditions, establish more reliable criteria of range readiness and indicate the proper grazing periods more accurately than has heretofore been possible. The high positive correlation found between the date of disappearance of winter snow and subsequent stages of plant development gives a reliable means of forecasting dates at which range readiness will be reached.

7. Plans for next year: With some revision in technique, the plant development observations will be continued and correlation plots will be harvested. A study will be made of the problem of devising a more satisfactory means of determining forage yield than the present correlation plots provide.

8. Date of completion: Indefinite.

9. Assignment: Lincoln Ellison.

RR - INT
Management
Summer Range

March 15, 1939

SUMMER RANGES: PHYSIOLOGICAL STUDIES OF RANGE PLANTS

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Summer ranges: Methods of managing high summer ranges in the mountainous regions of the West.

4. Purpose: To determine the effects on the physiological activities of the plant caused by clipping and grazing at various seasons and intensities.

5. Review of past work: In cooperation with the late Dr. E. C. McCarty of Riverside Junior College, studies were begun in 1932, and field work completed in 1936. One report has been published as USDA Tech. Bull. 598, 1938 describing the carbohydrate march in mountain brome. Herbage growth begins from a month and a half to three months before snow disappearance, and physiological activity continues even after the advent of winter snow. During the spring growing period no storage takes place and stored material is used up by the growing plant. Maximum storage of food reserves takes place in autumn after growth is complete. High concentrations of sugars in the basal organs seem to be associated with resistance to low temperatures and are essential to winter survival of the plants.

6. Accomplishments during past year: A manuscript, "Growth and Carbohydrate Food Ratios of Important Range Forage Plants and Their Reactions to Clipping and Grazing Treatments" is now in hands of the editor. In mountain brome, slender wheatgrass, sticky geranium and niggerhead, carbohydrate reserves are lower in clipped and grazed plants than in untreated ones. Forage yields and storage were lowest in plants clipped either continuously or during the active reproductive period, but clipping at 4 inches from ground level (as opposed to close clipping), even at 15-day intervals throughout the season, permitted a favorable storage of carbohydrates. Under moderate season-long grazing, mountain brome stored 59 percent and slender wheatgrass 70 percent as much carbohydrates as were stored by ungrazed plants, and under moderate grazing after seed maturity the proportions were 88 and 85 percent respectively. Moderate grazing seems essential and some form of deferred and rotation grazing needed so that, while the bulk of the forage may be utilized, plants will not be permanently injured.

A second manuscript is in preparation describing the effects of fall clipping upon the yield and vigor of browse species. In Cercocarpus and Symphoricarpos removal of current growth to 1 inch or more does not seem to harm the plants but to stimulate growth, although this material is coarser than that produced by the unclipped plant. Correct utilization for browse plants will probably have to be based on such key species as the palatable grasses.

7. Plans for next year: Clipping studies will be incorporated into the Utilization Standards project. Until further funds become available the chemical attack will be discontinued.

8. Date of completion: Completed under this project.

9. Assignment: Raymond Price to see carbohydrate paper through publication and to complete preparation of browse manuscript.

RR - INT
Management
Bunchgrass-Granitic Soil

March 15, 1939

SUCCESSIONAL STATUS OF BUNCHGRASS-GRANITIC SOIL RANGE VEGETATIONAL TYPES

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Summer ranges: Methods of managing high summer ranges in the mountainous regions of the West.

4. Purpose: To determine for bunchgrass-granitic soil vegetational types (1) the relation of the structure of the plant communities now occupying extensive range areas to their potential structure under protection or proper grazing management, and (2) the rapidity with which changes take place.

5. Review of past work: Inspections and surveys during the period 1929-1931 showed that the serious erosion problem on the Boise River watershed was largely the result of excessive grazing. A system of one hundred 1-meter quadrats and 105 25-square-meter plots was established in connection with 11 enclosures to study the natural vegetation of the watershed. Preliminary analyses of data obtained from these plots indicate that (1) the natural plant cover, when not weakened by excessive grazing, provides adequate watershed protection; (2) that on much of the area carefully controlled grazing will insure satisfactory recovery and maintenance of the natural plant cover, but (3) on the seriously depleted foothill ranges natural revegetation will not produce satisfactory stands under existing climate conditions, and artificial revegetation will have to be resorted to. Little exact information was provided concerning the course and rate of successional succession under the varying conditions by these early analyses.

6. Accomplishments during past year: Observations from major plots at Trinity Creek enclosure, which has an elevation of about 8,000 feet above sea level, showed the year to be quite favorable for Stipa lettermani seedlings. The plots examined showed many times as many seedlings as the same plots did in other years.

7. Plans for next year: Annual measurement of key plots will be continued for correlation with climatic and biennial measurement of all plots will be made to determine successional trends.

8. Date of completion: Indefinite.

9. Assignment: Lowell Woodward and George Stewart.

RR - INT
Management
Spring-Fall

March 15, 1939

ECOLOGY OF THE SAGEBRUSH-GRASS SPRING-FALL RANGES

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Spring-fall ranges: methods of managing foothills spring-fall ranges in the mountainous regions of the West.

4. Purpose of work: To determine for the sagebrush-grass spring-fall ranges the relation between environment and plant growth, with special attention to the relative importance of the various climatic factors on and the extent to which they influence plant growth and herbage production; the structure of the plant community and the rapidity with which changes take place; and the relation of the present community to grazing use.

5. Review of past work: Viscissitudes of climate as they affect the rate and character of plant growth is one of the most important factors in the management of native ranges. Similar stages of plant development from one year to another vary 40 days in the time of their occurrence. Flower stalk production is very uncertain and the production of viable seed relatively infrequent. Plant growth during the period from July 1 to October 1 occurs only about once every 5 years. Severe droughts result in severe and more or less protracted damage to the stands of perennial grasses -- damage which is not overcome during a single favorable year following the drought.

   Forage production, as indicated by density, has been found to vary from 60 percent above to 65 percent below the average with two or more deficient years occurring successively. Seasonal herbage production of Agropyron spicatum and Balsamorhiza sagittata follows the typical S-shaped curve characteristic of height growth. Recovery of spring-fall sagebrush-grass range areas that show retrogression of the type is extremely slow. This may be attributed to the almost complete dominance of big sagebrush, Artemisia tridentata on the area.

6. Accomplishments during the past year: For the first time since the 1934 drought, basal area of Agropyron spicatum was definitely increasing, although some slight but insignificant increases occurred in 1937.

7. Plans for next year: This subproject will be continued as planned during 1939.

8. Date of completion: Indefinite.

9. Assignment: Joseph F. Pechanec and George Stewart.

RR - INT
Management
Spring-Fall

March 15, 1939

METHODS OF HANDLING SAGEBRUSH-GRASS
SPRING-FALL RANGES UNDER GRAZING USE

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Spring-fall ranges: methods of managing foothills spring-fall ranges in the mountainous regions of the West.

4. Purpose of work: To determine for the sagebrush-grass spring-fall ranges the effect of different methods of grazing management, and different seasons and intensities of grazing upon sustained forage production, plant species reaction and animal response.

5. Review of past work: Investigations begun in 1923 indicate that continuous fall grazing, receiving about 60 percent utilization of key grass species, is not detrimental; spring grazing practiced continuously under the approximate intensity commonly used on adjacent open ranges continued for a 15-year period, results in the almost complete extermination of valuable forage species and the serious encroachment of big sagebrush; fairly heavy grazing consistently during any single part of the spring grazing period is detrimental to the maintenance of forage productivity; to obtain fullest sustained use of these ranges rotation of grazing seems necessary.

During the drought of 1934, rotation and rotation-deferred systems proved superior to continuous grazing. From the standpoint of forage maintenance the rotation-deferred seemed slightly superior to the rotation system. Ewes suckling lambs gained more under the rotation and rotation-deferred pasture systems than under herded conditions.

Animal response to a certain extent appears to be inverse to the intensity of grazing.

Since summer growth is undependable, a portion of the current spring forage should be reserved for fall use. Proper use of Agropyron spicatum should be 30 percent of the current herbage growth in the spring and a total of 60 percent by the end of the fall season.

Removal of sagebrush with grass understory permits the fullest benefits to accrue from management systems. Increases in forage production of 150 percent in two years resulted from removal of sagebrush by fire followed by proper grazing management.

6. Accomplishments during the past year: Since an unusually good forage crop provided sufficient feed on even the most heavily stocked pastures, system and intensity this year played but little part in animal gains.

7. Plans for next year: All study phases will be continued during 1939 as planned.

8. Date of completion: Present phases - 1940, with some modification needs to be continued indefinitely.

9. Assignment: Joseph F. Pechanec.

RR - INT
Management
Spring-Fall

March 15, 1939

METHODS OF STUDYING SAGEBRUSH-GRASS SPRING-FALL RANGE VEGETATION

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Spring-fall ranges: methods of managing foothills spring-fall ranges in the mountainous regions of the West.

4. Purpose of work: To determine the most efficient methods of measuring native range vegetation and to investigate the nature of variation in experimental material being used, methods of sampling, and types of experimental design that may increase the efficiency of range experimentation.

5. Review of past work: Testing adaptability of methods of studying native range vegetation was actively begun in 1932. The adaptability of the point-observation-plot method of determining plant density and of the coordinate method of mapping shrubs was studied and both methods found suitable for this type range. The stem-count method of determining percentage utilization was found too inaccurate for use in experimental studies. A study of several methods of determining percentage utilization indicated that the ocular-estimate-by-plot methods used in conjunction with checking of estimates provided a fairly reliable means of securing information concerning utilization of sagebrush-grass ranges. The weight-estimate method was designed, tested and found superior to estimates of density.

   Covariance analysis as a means of improving the efficiency of range experiments seems to have very promising possibilities.

6. Accomplishments during the past year: Range research is faced with variations in experimental material three to seven times as great as that found in agricultural experiments and when the present types of sampling units are used strongly skewed distributions are found. Personal error in rapid estimate methods is far less serious than the lesser intensity of sampling that accompanies the more tedious exact clipping methods. Sampling to an intensity two to three times as great as now employed, smaller pastures or experimental units and more efficient design seem to be definitely necessary to insure more successful experimentation.

7. Plans for next year: The study of sampling native range vegetation will be continued with special emphasis upon the use of random sampling within experimental pastures and vegetational types.

8. Date of completion: Indefinite.

9. Assignment: Joseph F. Pechanec.

RR - INT
Management
Winter Range

March 15, 1939

ECOLOGICAL FACTORS AFFECTING RANGE FORAGE PLANTS

1. Field division: Range research.

2. Work project: Management winter ranges.

3. Line project: Ecological factors affecting range forage plants.

4. Purpose: To determine (1) the relative influence of the various climatic and soil factors on forage production; (2) the effect of climatic fluctuations on plant growth; and (3) the adjustments in range management necessary to compensate for the variability in forage yield.

5. Review of past work: Climate at the Desert Range Branch is extremely variable. Precipitation is erratic and varies greatly from season to season and from month to month. In 1933 (June to October) rainfall was only 0.33 inch, whereas for the same period in 1935 it was 4.00 inches. Summer storms are frequently localized and often occur as torrential downpours, causing rapid run-off. Winter snowfall is also variable. Frequently one locality will receive from 5 to 10 inches of snow, when part of the same valley and adjacent valleys will be suffering from a lack of precipitation. Forage growth varies as much as 300 percent between dry and wet seasons and as much as 250 percent on localized areas during a single season. Since use of the major portion of the winter ranges of the Intermountain region is dependent on snowfall, range management must be flexible enough to meet the variations in forage production that arise from vicissitudes of climate.

6. Accomplishments during past year: Precipitation during 1938 was 9.68 inches, 26 percent greater than that of any season since the establishment of the Desert Branch Station in 1933. Approximately 66 percent of the annual precipitation for 1938 fell prior to July 30. As a result, plant growth and forage production were from 20 to 35 percent greater than in any preceding year. Practically all plant species made exceptional growth because of the relatively heavy winter precipitation followed by timely spring and early summer rainfall.

7. Plans for next year: Study will be continued and 5-year plant growth and weather data will be compiled and analyzed.

8. Date of completion: Indefinite.

9. Assignment: Selar S. Hutchings.

RR - INT
Management
Winter Range

March 7, 1939

UTILIZATION, SEASONAL USE, AND ANIMAL RESPONSE

1. Field division: Range research.

2. Work project: Management winter ranges.

3. Line project: Utilization, season, and intensity of grazing.

4. Purpose: To determine (1) degree of utilization that will insure rehabilitation of desert ranges and insure their maintenance in perpetuity; (2) the relative influence of intensity and season of use on plant cover and forage production; and (3) the influence of degree of utilization on condition of sheep as reflected in the weight of animals and the volume of animal products.

5. Review of past work: Eighteen 320-acre pastures stocked since 1936-37 indicate the proper intensity of grazing at the experimental range to be approximately 0.04 forage-acre a head per month which requires approximately $2\frac{1}{2}$ acres a head per month. Improvement of the plant cover under proper stocking indicates that the rate of stocking can now be increased from one-fourth to one-third. Plant vigor and herbage yields have increased fully twice as much as has the plant density.

   During a 40-day winter pasture study the average change in weight of sheep under heavy, moderate, and light use was -3.45, + 3.76, and + 5.98 pounds, respectively. On properly grazed herd allotments on the experimental range, ewes gained 4.57 pounds in 42 days and lambs 2.88 pounds. Two flocks of sheep alternate yearly between the moderately grazed experimental area and the heavily grazed open range. The herd on the experimental range produced 0.83 pound more wool per animal, a 4 percent greater lamb crop, and wintered in better flesh without the aid of supplemental feed than those grazed on the open range, which were fed during the winter $400 worth of cottonseed cake.

   The net profit on the herd wintered on the experimental range under properly managed range was 58 cents per head greater than for the herd wintered under outside conditions.

6. Accomplishments during past year: Average change in weight of sheep grazed at the Desert Range Branch Station during the fall of 1937 under heavy, moderate, and light grazing was -0.32, +3.50, +7.42 pounds respectively; during the winter period -3.55, +2.80, +5.21 respectively; and during the spring period +4.15, +10.25, +8.10

pounds. Fleeces averaged one-third pound a head more and the lamb crop was approximately 7 percent greater than for the flock wintered on the adjacent open range.

7. Plans for next year: Continue studies on influence of degree of use on condition of sheep and range forage production.

8. Date of completion: Indefinite.

9. Assignment: George Stewart and Selar S. Hutchings.

RR - INT
Management
Winter Range

March 15, 1939

SUCCESSIONAL STUDIES IN RANGE PLANT TYPES

1. Field division: Range research.

2. Work project: Management winter ranges.

3. Line project: Successional studies in range plant types.

4. Purpose: To determine (1) general condition of winter ranges in respect to plant cover; (2) the degree and rapidity of recovery and natural revegetation on properly managed and totally protected ranges; (3) the role of establishment and increase in vigor of the better forage plants; (4) the management methods best adapted to meet the requirements for production of plants and yet serve the livestock to the greatest possible degree.

5. Review of past work: General surveys of the winter ranges in western Utah and Nevada indicated that the plant cover had been reduced 34 percent from pristine conditions and forage volume had decreased 62 percent as a result of heavy grazing and improper seasonal use. Forage volume more than doubled on typical winter ranges in western Utah subjected to proper use for a period of 5 years. Areas totally protected from grazing for 2 to 5 years show a marked increase in plant vigor, plant cover, and soil stabilization. Forage production on these areas is now from 1.5 to 2.5 times greater than on the adjacent open range. Indian ricegrass (Oryzopsis hymenoides) produces 3 to 6 times more forage per plant on the protected enclosure than on the open range. In protected enclosures and on properly utilized range units Russian-thistle (Salsola pestifer), rabbitbrush (Chrysothamnus stenophylus) and other inferior forage plants abundant on the open range have almost disappeared. Seedling production and survival of the better forage plants is 2 to 4 times greater on the enclosed areas. On properly utilized ranges 20 to 25 percent of the better forage plants should be left and only 50 to 55 percent of the total current herbage should be taken.

6. Accomplishments during past year: Total plant cover has made increases of 33 to 58 percent on 4 enclosures established in 1932. Indian ricegrass (Oryzopsis hymenoides) shows an increase of from 2.0 to 5.5 times during a 5-year period. Galleta grass (Hilaria jamesii) and winterfat (Eurotia lanata) show average increases of approximately 2.7 and 1.8 times, respectively. Shadscale (Atriplex confertifolia) shows only slight increase on the protected areas; rabbitbrush, an inferior forage species, has

decreased 33 percent on the protected areas but has increased 1.5 times on the open range. Favorable precipitation has brought about extremely slight changes in a number of the better forage plants, galleta grass, for example, increasing only 0.40 of 1 percent.

7. Plans for next year: Additional enclosures established since 1932 will be estimated and data analyzed.

8. Date of completion: Indefinite.

9. Assignment: Selar S. Hutchings and George Stewart.

RR - INT
Management
WRS

March 15, 1939

WESTERN RANGE SURVEY

1. Field division: Range research.

2. Work project: Grazing management.

3. Line project: Western range survey: cooperative western range survey.

4. Purpose: To determine grazing capacity of all range lands in Wasatch County, Utah and Gem County, Idaho and of privately owned range lands in other counties of the Intermountain region subject to AAA benefit payments and of such other lands in these counties as have been adequately surveyed for grazing capacity. Survey to be a basis for developing overall grazing plans in completely surveyed counties, and for initiating better range practices on individual holdings, and on cooperative units of diverse onwership.

5. Review of past work: Inventory survey began June 1937; cooperative field parties in Wasatch and Gem Counties surveyed areas not covered by AAA appraisals, or by SCS and national forest surveys. AAA field data largely checked and other data compiled and analyzed for forage inventory, and for the location of problem areas.

6. Accomplishments during past year: Compilation completed; recommendations for better grazing management and practices of all range lands in Wasatch County and Gem County were prepared as mimeographed reports, which included such recommended betterment practices as adjustment of livestock numbers to the grazing capacity, adjustments in seasonal use, erosion control, reseeding, use of superior livestock, and the development of watering places and fences. Partial recommendations were also prepared for those counties not having a complete survey but in which data were available for considerable areas as a result of AAA appraisals, and of regular surveys by the Utah Experiment Station, the Forest Service, and the then-called Resettlement Administration. Shorter reports were prepared for Summit, Utah, and Uintah Counties in Utah; Oneida and Elmore Counties in Idaho; Elko County, Nevada; and Sublette County, Wyoming. Still briefer reports were prepared for Weber and Iron Counties in Utah, and for Bingham, Owyhee, and Washington Counties in Idaho, where the only data were from large total acreages appraised by AAA. Gem County, Idaho was reexamined and a report prepared regarding the 1938 grazing capacity, which was much higher than that of 1937. Increased forage production in 1938, largely of

Bromus tectorum, agreed to on the ground by the SCS, the Division of Grazing, and the Forest Service, was thought to be the result of increased and better distributed precipitation and mild winter conditions.

7. Plans for next year: Since no funds are available for this project, it is suspended for the present, except that arrangements have been made with the agencies concerned to cooperate in keeping up to date an areal map of completed surveys.

8. Date of completion: Present phase completed.

9. Assignment: George Stewart.

RR - INT
Artificial Regeneration
Species

March 15, 1939

SUITABILITY OF PLANT SPECIES FOR ARTIFICIAL REVEGETATION

1. Field division: Range research.

2. Work project: Artificial revegetation.

3. Line project: Species; suitability of plant species for artificial revegetation.

4. Purpose: To determine which forage species, whether native, imported, or produced by plant breeding, are best adapted to the various problem areas of the Intermountain region.

5. Review of past work: Recent extensive plantings have indicated that for each soil and climatic region a few species have made good growth and appear to be well suited for reseeding. On the driest sites, where soil is depleted of nitrogen, bulbous bluegrass (Poa bulbosa) and tall oatgrass (Arrhenatherum elatius) have done well. Areas with somewhat better soil and moisture conditions, such as abandoned farm lands and moderately depleted range in the sagebrush-grass type can support crested wheatgrass (Agropyron cristatum), blue stem (A. smithii), and in the better niches, slender wheatgrass (A. pauciflorum). On the higher summer ranges, smooth and mountain bromegrasses (Bromus inermis and B. carinatus) and slender wheatgrass have done well.

6. Accomplishment during past year: All of the species which made promising showings in the early stages of trials, as listed above, have continued to grow and are becoming established. In addition, a few other species have shown themselves worthy of further attention. In nursery trials, Poa ampla, P. nevadensis, Elymus glaucus, and E. canadensis have produced vigorous growth, and warrant more extensive trials. Four native grasses, Stipa arida, Bouteloua gracilis, Oryzopsis hymenoides, and Hilaria jamesii have shown promise on some dry sites. The search for legumes suitable for range reseeding was advanced by successful nursery plantings of native lupine (Lupinus ornatus) in Idaho and early Korean lespedeza (Lespedeza stipulacea) in Utah. Cuttings of native rose (Rosa fenderi) and 1-0 nursery stock of black locust (Robinia pseudoacacia) planted on the raw granitic soils of the Boise National Forest have survived 60 percent and 84 percent after one year.

7. Plans for next year: Promising species in older plantings will be closely observed to determine their survival, longevity, yield and general value. Yields will be estimated by a modification of the weight estimate method of Pechanec and Pickford. Extensive trials of newly found promising species will be made as rapidly as seed becomes available through either collection, exchange, purchase, or plant breeding studies.

8. Date of completion: The preliminary and exploratory phases of the project are well along; the project will be continued indefinitely to test newly acquired and developed species and strains.

9. Assignment: George Stewart, C. Kenneth Pearse, and A. C. Hull.

RR - INT
Artificial Revegetation
Site Factors

March 15, 1939

SITE FACTORS: SOILS, CLIMATE, ALTITUDE, AND OTHER FACTORS AFFECTING ARTIFICIAL REVEGETATION

1. Field division: Range research.

2. Work project: Artificial revegetation.

3. Line project: Site factors: soils, climate, altitude and other factors affecting artificial revegetation.

4. Purpose: To determine the effect of site factors on the growth and ultimate forage production of species used in artificial revegetation.

5. Review of past work: Not only the parent material, but also the morphological development of soils of the region have been shown to vary widely. These variations strongly influence results of revegetation work because of differences in water relations and mineral nutrient content of various soils. Tests have shown that many western range soils are very low in nitrogen-fixing bacteria, an important fact, since nitrogen deficiency is likely a serious limiting factor in reseeding. Failure of several grass species to seed at higher elevations has been ascribed to shortness of growing season.

6. Accomplishments during past year: Competition with native vegetation is felt to be responsible for many cases of poor establishment of reseeded grasses, since grubbed plots have done much better than ungrubbed ones. Competition is especially severe in thick stands of sagebrush, annual weeds, or cheatgrass. Trials with Poa bulbosa, Agropyron cristatum, and A. spicatum have indicated that the first of these species is very aggressive and usually can spread among cheatgrass and probably other species.

   Soil fertility studies, conducted in the greenhouse, have provided further evidence that many range soils are too low in mineral nutrients to support vigorous grass stands, although this is by no means universally true. The problem of the fertilizer needs of some range soils, aside from the question of cost of application on large areas, is very real. One possible approach to this problem is through including soil-building legumes in plantings on depleted soils.

7. Plans for next year: Studies of soil characteristic, and competition with native species will be continued and accumulation of basic data for the study of the relation of climate to artificial revegetation will be begun.

8. Date of completion: Indefinite.

9. Assignment: A. C. Hull, C. Kenneth Pearse, and George Stewart.

RR - INT
Artificial Revegetation
Methods

March 15, 1939

METHODS: TIME, DEPTH, CULTURE, PRACTICABILITY & COST OF PLANTING

1. Field division: Range research.

2. Work project: Artificial revegetation.

3. Line project: Methods: time, depth, culture, practicability, and cost of planting.

4. Purpose: To determine the most practical time and methods of sowing or transplanting and subsequent treatment in the revegetation of depleted ranges.

5. Review of past work: The need for covering seed in order to obtain satisfactory stands on the dry ranges of the Intermountain region has been demonstrated, and drilling, trampling with sheep, harrowing, plowing furrows 3 feet apart, and brush dragging have been shown to be promising methods of accomplishing this end. With most species and on most sites, fall seeding has been most satisfactory.

6. Accomplishments during past year: Evidence has accumulated to show that drilling grass seed is generally a better method of seeding than trampling with sheep, harrowing, or brush dragging, It has been found that commercial drills can be used on rough, comparatively rocky and brushy areas far more successfully than was previously imagined. Special modification of 1-horse drills enable these machines to be used on slopes as steep as 65 percent.

The most satisfactory rate of seeding has been found to depend on soil and moisture conditions of the site, as well as on the size, purity, and viability of the seed. For the most commonly seeded species 4 to 8 pounds an acre seem best. (These rates produce satisfactory stands at considerable saving in cost of seed over the rates of 10 or more pounds previously used.)

Greenhouse work has indicated that the shallower seeds can be planted and still receive adequate and reliable soil moisture supplies, one-fourth inch being optimum for all species watered daily. Under field conditions the seed must be planted deep enough to insure a continuous moisture supply after germination has begun. For small seeded species, as Poa bulbosa, depths greater than 1 inch, and for larger seeded species depths greater than 2 inches, produced inferior stands.

Planting of shrub cuttings and nursery stock of trees was found to be feasible on depleted watershed areas, but the need was shown for supervision of planting crews to insure correct procedure. Fall planting was superior to spring planting except for species with straight, smooth below ground parts which were subject to frost heaving.

Two types of hand machines for collection of native grass seed growing in small stands have been successfully developed.

7. Plans for next year: Detailed studies of time, rate and depth of seeding of the principal species adapted for each site will be continued and added emphasis will be placed on the application of results to large scale plantings, including development and testing of special machinery.

8. Date of completion: Indefinite.

9. Assignment: C. Kenneth Pearse, A. C. Hull, and Lowell Woodward.

RR - INT
Artificial Revegetation
Plant Breeding

March 15, 1939

PLANT BREEDING - SELECTION AND HYBRIDIZATION

1. Field division: Range research.

2. Work project: Artificial revegetation.

3. Line project: Plant breeding: Selection and hybridization (conducted cooperatively with the Bureau of Plant Industry and the Utah State Agricultural Experiment Station, with the Bureau of Plant Industry acting as leader and prosecuting the detailed work).

4. Purpose: To produce improved strains of range plants by selection. To determine the pollen production and quality, and pollination and seeding habits of range plants as a basis for hybridization studies; and to produce improved strains of range plants by hybridization.

5. Review of past work: Several hundred plants of the more promising species for revegetation work were set out as single plants in order to study their variability and growth habits. These have developed rapidly and preliminary selections of strains on the basis of leafiness, seed production, or erectness have been made. A supply of self-pollinated seed has been obtained by means of bagging in order to provide homozygous material with which to begin hybridization studies.

6. Accomplishments during the past year: Six mass selection strains of Agropyron smithii and four strains of Bromus inermis chosen for various desirable characteristics have been planted at several nurseries and plants are becoming established. The selection work and inbreeding work has been continued in order to prepare the way for the hybridization work to follow.

7. Plans for next year: The work will be continued on very much the same basis as it has been conducted during the past three years. As soon as desirable pure strains are available crossing will be attempted.

8. Date of completion: Indefinite.

9. Assignment: Bureau of Plant Industry.

RE - INT
Range Economics March 15, 1939

AREA STUDIES IN RANGE ECONOMICS

1. Field division: Range economics.

2. Work project: Range economics.

3. Line project: Area studies in range economics.

4. Purpose: To evaluate, for selected areas, economic and social effects of different alternatives of policy in use and management of public lands for grazing by farm and ranch livestock.

5. Review of past work: During 1937 and prior to May 15, 1938 work was limited to cooperation with federal and state agencies interested in the range and soil inventory and the study of land use and ranch management problems in the northeastern Nevada area largely in Elko County. About three-fourths of the inventory phases of this work were completed by the fall of 1938, and compilation undertaken by the various agencies.

6. Accomplishments during past year: The work during the past year has been to (1) develop the general background regional picture of range land use areas and problems. This picture shows great extremes between areas and within areas in the use of the public land for different sizes and types of farms and ranches. Indications are that in some areas the future adjustments in public land grazing will be directed primarily toward improved economic and social use of the resource; in other areas resource conservation will predominate.

(2) Made preliminary surveys of certain area problems. A preview study of capitalization of privately owned ranch lands and costs of range land use in Cache, Rich, Weber, Morgan, Summit, and Wasatch Counties, Utah shows that private lands have closely related problems in management and conservation to those of the public lands used for grazing.

A preliminary study of early lambing of farm flock sheep kept yearlong on irrigated farms near Delta, Utah indicates a better labor income than was obtained from range farm flocks producing fall marketed lambs. It is also indicated that the farm beef cattle outfits using the range should consist of at least 30 head, and farm flock sheep outfits of not less than 100 ewes.

(3) Developed procedure for comprehensive economic analysis. A study of the permit data of the Fishlake National Forest and of AAA farm and livestock data of Sevier Valley has been used to develop procedure for developing a farm and ranch dependency rating for use of public land grazing.

7. Plans for next year: A study of area land use and economy will be carried out for one of the southern Utah national forests, in cooperation with Range Management, R-4, and, if resources permit, a similar study of the Sawtooth National Forest in Idaho.

8. Date of completion: Indefinite.

9. Assignment: Mont H. Saunderson.

INFLUENCES

RI - INT
Watersheds
Stream Flow - Great Basin

March 15, 1939

STREAM FLOW (TREE, SHRUB, GRASS)

1. Field division: Forest and range influences.

2. Work project: Influence of natural vegetation on stream flow.

3. Line project: Woodland cover: Relation of woodland cover (tree, shrub, grass) to stream flow.

4. Purpose: To determine on watersheds and plots the management practices which will assure the greatest yield in quantity and quality of stream flow and maintain optimum soil conditions.

5. Review of past work: In the Great Basin about 80 percent of stream flow originates largely from melted snow on range lands above 7,000 feet elevation. In Utah 1¼ billion dollars is largely dependent on such stream flow. Spring run-off, when demand by users is low, amounts to 65 to 90 percent of the total annual flow, whereas July, August, and September flow, when demand is high, may not exceed 6 percent of the annual yield. Apparently south aspects differ from north aspects in quality of water yielded. Surveys indicate that quality of stream flow has been changed as a result of watershed utilization. In many instances destructive mud-rock flows have done much damage to valley property and potential floods continue to threaten the social and economic well-being of many communities. Studies involving the complicated relationships of kind and density of plant cover, climate, physiography, soil, and stream flow are under way on 8 watersheds and 16 small plots.

6. Current accomplishments: Sixteen waterstage recorders on watersheds with permanent streams have been kept in operation on a yearlong basis. Significant progress has been made in inventorying watershed soil, plant cover and physiographic features on the Farmington Canyon experimental watersheds. Ten miles of contour trails have been built and construction of housing facilities in Farmington Canyon is under way.

7. Plans for next year: Complete work listed under 6 above.

8. Date of completion: Indefinite.

9. Assignment: A. R. Croft.

RI - INT
Watersheds
Stream Flow - Great Basin March 8, 1939

STREAM FLOW (HERBACEOUS VEGETATION)

1. Field division: Forest and range influences.

2. Work project: Influence of natural vegetation on stream flow.

3. Line project: Grassland: The role of grassland in influencing stream behavior.

4. Purpose: To determine on small watersheds and plots the management practices that will maintain plant cover conditions favorable for optimum surface run-off and prevention of accelerated soil erosion.

5. Review of past work: The effect of grasses and other herbaceous plant cover in controlling surface run-off and erosion was determined by studies on watersheds A and B on the Wasatch Plateau prior to 1929. Reversal of plant cover densities since 1935 on these two watersheds establishes that plant cover relationships are more important in controlling run-off and erosion on these areas than other differences that may exist between them, such as size, shape, slope, or gully pattern. Destructive floods and accelerated soil erosion throughout the region have been shown by observations to be correlated with reduced herbaceous plant cover and excessive disturbance of soil by grazing. As a basis for further study of the influence of this type of cover on erosion and run-off, six 1/10-acre plots have been established at the Great Basin Experiment Station, and twenty-four 1/200-acre plots have been established on foothill lands in Davis County, Utah.

6. Current accomplishments: Analysis of data from A and B watersheds since reversal of plant cover begun in 1936 reveal that A/B run-off and erosion ratios have changed from 2.27 to 0.56 and from 2.50 to 0.55, respectively.

7. Plans for next year: Operate all phases of studies related to project.

8. Date of completion: Indefinite.

9. Assignment: A. R. Croft.

RI - INT
Watersheds
Stream Flow - Idaho

March 15, 1939

STREAM FLOW (BUNCHGRASS-GRANITIC RANGE, IDAHO)

1. Field division: Forest and range influences.

2. Work project: Influence of natural vegetation on stream flow.

3. Line project: Grassland: role of grassland in influencing stream behavior.

4. Purpose: To determine for bunchgrass-granitic soil range lands of southern Idaho, the management practices required for maintaining cover conditions that will yield maximum quantities of usable stream flow.

5. Review of past work: Surveys have shown abnormally rapid run-off of silt-laden water to be due to depletion of the perennial bunchgrass cover on range lands. Subsequent detailed studies have shown that infiltration decreases and surface run-off increases with (a) degree of plant cover depletion, and (b) organic matter losses from the surface soil, suggesting maximum yields of ground water can be obtained by maintaining bunchgrass cover on the range. In 1935 two 10-acre, and in 1937 three 200-acre watersheds were equipped with run-off measuring devices to determine the extent to which range use influences run-off relationships.

6. Accomplishments during past year: The experimental watersheds were maintained in operation.

7. Plans for next year: (a) Continue operation of five experimental watersheds. (b) Prepare detailed topographic, plant, and soil map of the Arrowrock triplicate watersheds.

8. Date of completion: Indefinite.

9. Assignment: Lowell Woodward.

RI - INT
Water Cycle
Lysimeters
Idaho

March 15, 1939

WATER LOSSES (BUNCHGRASS-GRANITIC SOILS, IDAHO)

1. Field division: Forest and range influence.

2. Work project: Water utilization by vegetation.

3. Line project: Range forage: relation of water requirements of range forage species.

4. Purpose: To determine on the bunchgrass-granitic range lands of southern Idaho, the kind of range cover that is required for minimizing evapo-transpiration water losses.

5. Review of past work: The climax, perennial bunchgrass cover has been found to be more effective for inducing infiltration and preventing erosion than secondary weed and annual weed successional stages; but the relative evapo-transpiration losses of areas in these successional stages is not known. A battery of six 2-milacre steel lysimeters were installed at the Bannock Creek substation in 1932. Three years of record show that 4-foot profiles of homogeneous, bare granitic soil retain and evaporate about 60 percent of the annual precipitation. Nearly all of the net yield occurs as seepage during and immediately after snow melt. In 1937 two each of the lysimeters were planted to plants of climax, secondary weed, and annual weed successional stages.

6. Accomplishments during past year: The lysimeter battery has been maintained in operation and vegetation has made a good start.

7. Plans for next year: Maintain lysimeter battery in operation and improve automatic recording device for measuring run-off.

8. Date of completion: Indefinite.

9. Assignment: Lowell Woodward.

RI - INT
Watersheds
Soil Stability - Great Basin March 15, 1939

SOIL STABILITY (FOREST, BRUSH, GRASSLAND)

1. Field division: Forest and range influences.

2. Work project: Stabilization of soil.

3. Line project: Watersheds: Relation of forest, brush, grassland cover and management practices to erosion, and soil stability and quality and usability of stream flow.

4. Purpose: To determine on watersheds and plots (1) management practices which will maintain soil stability and normal stream flow; and (2) methods for rehabilitating depleted soil and water yield.

5. Review of past work: Extensive observational and limited research data indicate excessive accelerated erosion throughout the region, on mixed forest, brush, and grasslands, often seriously affecting quality of water yield. Data from small watersheds and plots together with extensive observations indicate plant cover is the key to the erosion situation. Methods have been developed to determine qualitative and quantitative soil losses produced by accelerated erosion. Approximately, 2,000 permanent plots have been established and sampled and soil analyzed, covering all study areas. From 21 localities along 175 miles of transect about 2,000 other sites have been sampled and soil analyzed. Accelerated erosion reduces organic matter, total nitrogen, and moisture equivalent as much as 70, 39, and 67 percent, respectively.

6. Current accomplishments: Methods for qualitative and quantitative determinations of accelerated erosion have been refined. A soil survey of 5 experimental watersheds has been made involving locating and marking 1,400 plots and securing 2,800 composite soil samples.

7. Plans for next year: Complete soil inventory on experimental watersheds, make laboratory analysis of samples, analyze data.

8. Date of completion: Indefinite.

9. Assignment: A. R. Croft.

RI - INT
Watersheds
Soil Stabilization
Idaho

March 15, 1939

SOIL STABILITY - (BUNCHGRASS-GRANITIC RANGE, IDAHO)

1. Field division: Forest and range influences.

2. Work project: Stabilization of soils.

3. Line project: Watersheds: relation of forest, brush, and grassland cover and management practices to erosion and soil stability and to quality and usability of water.

4. Purposes: To determine on bunchgrass-granitic range lands of southern Idaho (1) the range utilization practices required for maintaining soils in place, and (2) the improvement measures needed to stabilize soil on eroding areas.

5. Review of past work: Surveys have revealed serious accelerated erosion to be widespread on the range portion of Boise River and other watershed areas in southern Idaho. Detailed studies show that erosion increases with degree of range cover depletion, steepness of slope, soil disturbance and intensity of rainfall. Restoration of perennial bunchgrass cover on depleted areas is required, but natural revegetation is uncertain due to adverse climate, soil, and use factors. In 1935, two 10-acre watersheds were fenced and equipped with run-off and erosion measuring devises to determine effects of range use on erosion relationships. Three 200-acre watersheds were selected in 1936 for similar purposes but while these are equipped with run-off gages, they do not as yet have debris basins for measuring erosion. Intensive studies of erosion control methods were initiated at the Arrowrock Substation in 1937. The most effective measures tested thus far include: contour seeding, contour furrowing, shrub planting in gullies, and complete exclusion of grazing.

6. Accomplishments during past year: Contour seeding, contour furrowing, and shrub planting was extended to about 500 acres of demonstration watershed land as a preliminary phase of a combination erosion control and artificial revegetation study. The soil stability study will involve measurements of erosion on treated and untreated areas with portable rainmaker and erosion apparatus. The specifications developed for application on the Arrowrock demonstration area were used for planning control operations by the Boise River Flood Control Survey Project.

7. Plans for next year: (a) Test effectiveness of artificially reseeded and contour furrowed areas for controlling erosion with portable rainmaker apparatus; (b) construct debris basins on Arrowrock triplicate range watersheds; (c) maintain erosion records on Bannock Creek A-B watersheds.

8. Date of completion: Indefinite.

9. Assignment: Lowell Woodward.

RI - INT
Surveys
FCS

March 15, 1939

FLOOD CONTROL PRELIMINARY EXAMINATION & REPORTS

1. Field division: Flood control surveys.

2. Work project: Flood control surveys.

3. Line project: Preliminary examinations: examination of watersheds to determine existence of flood problems.

4. Purpose: To determine the existence of flood problems and the need for the detailed surveys of measures required for flood control, run-off retardation and erosion prevention purposes within the Upper Snake River drainage basin.

5. Review of past work: Field work has been completed for preliminary reports on the Snake River and its tributaries in Wyoming.

6. Accomplishments during the past year: Participation of Flood Control Public Hearings covering all major tributaries of the Snake River drainage basin.

7. Plans for next year: Prepare preliminary report upon Weiser, Upper Snake (above Idaho Falls) and Payette Rivers.

8. Date of completion: 1940.

9. Assignment: Field Coordinating Committee 17B:

   Reed W. Bailey, Chairman (FS)
   J. H. Christ (SCS)
   Edwin E. Wilson (BAE)

   Field Working Committee:

   George W. Craddock, Chairman (FS)
   H. M. Wanser (SCS)
   Carl Tjerandsen (BAE)

   Project Leader: _____

RI - INT
Surveys
FCS

March 15, 1939

FLOOD CONTROL PRELIMINARY EXAMINATIONS AND REPORT

1. Field division: Flood control surveys.

2. Work project: Flood control surveys.

3. Line project: Preliminary examinations: examination of watersheds to determine existence of flood problems.

4. Purpose: To determine the existence of flood problems and the need for detailed surveys of measures required for flood control, run-off retardation and soil erosion prevention purposes within the Bonneville Lake basin of the Great Basin and the Upper Colorado River drainage basins.

5. Review of past work: Field work has been completed on the Upper Green River and its tributaries in Wyoming.

6. Accomplishments during the past year: Participation in flood control public hearings covering all major tributaries of the Bonneville Basin and Upper Colorado River drainage basin.

7. Plans for next year: Prepare preliminary reports upon the San Pitch-Salina tributaries of the Sevier River and the Weber River; and participate in preparation of reports upon the Virgin, the Price-San Rafael, and the Upper Colorado (above junction with Green) Rivers.

8. Date of completion: 1940.

9. Assignment: Field Coordinating Committee 17A:

Reed W. Bailey, Chairman (FS)
H. G. Calkins (SCS)
Edwin E. Wilson (BAE)

Field Working Committee:

George W. Craddock, Chairman (FS)
Arthur Fife (SCS)
Leonard Hill (BAE)

Project Leader _____

RI - INT
Surveys
FCS

March 15, 1939

FLOOD CONTROL PRELIMINARY EXAMINATIONS AND REPORT

1. Field division: Flood control surveys.

2. Work project: Flood control surveys.

3. Line project: Preliminary examinations: examination of watersheds to determine existence of flood problem.

4. Purpose: To determine the existence of flood problems and the need for detailed surveys of measures required for flood control, run-off retardation and soil erosion prevention purposes within the Lahontan Lake Basin of the Great Basin drainage basin.

5. Review of past work: New project.

6. Accomplishments: Participation in flood control public hearings on the Humboldt River and other tributaries of the drainage basin.

7. Plans for next year: Initiate report upon the Humboldt River.

8. Date of Completion: 1940.

9. Assignment: Field Coordinating Committee 17C:

Reed W. Bailey, Chairman (FS)
Harry Reddick (SCS)
Edwin E. Wilson (BAE)

Field Working Committee:

George W. Craddock, Chairman (FS)
_____ (SCS)
Leonard Hill (BAE)

RI - INT
Surveys
FCS

March 15, 1939

BOISE RIVER WATERSHED SURVEY

1. Field division: Flood control surveys.

2. Work project: Flood control surveys.

3. Line project: Watershed surveys: detailed survey of approved watersheds for preparing action program.

4. Purpose: To determine the kind, cost, and benefits of measures needed to be applied for flood control, water flow retardation and soil erosion prevention purposes on the watershed lands of the Boise River, Idaho.

5. Review of past work: New project.

6. Accomplishments during the past year. Interim report completed covering recommendations for application of remedial measures on the Willow Creek Work Unit, comprising 3 percent of the watershed.

7. Plans for next year: Complete watershed field work and prepare report on entire watershed.

8. Date of completion: 1940. (Tentative, contingent upon completion of siltation study being conducted by U. S. Geological Survey).

9. Assignment: Field Coordinating Committee 17B:

Reed W. Bailey, Chairman (FS)
J. H. Christ (SCS)
Edwin E. Wilson (BAE)

Field Working Committee:

George W. Craddock, Chairman (FS)
H. M. Wanser (SCS)
Carl Tjerandsen (BAE)

Project Leader: Thomas H. VanMeter (FS)

APPENDIX

APPENDIX

A. Publications during the calendar year 1938

I. Departmental publications

Craddock, George W., and Forsling, C. L. The influence of climate and grazing on spring-fall sheep range in southern Idaho. USDA Tech. Bull. 600. 1938.

_____ and Pearse, C. Kenneth. Surface run-off and erosion on granitic mountain soils of Idaho as influenced by range cover, soil disturbance, slope, and precipitation intensity. USDA Circ. 482. 1938.

McCarty, Edward C. The relation of growth to the varying carbohydrate content in mountain brome. USDA Tech. Bull. 598. 1938.

Price, Raymond. Artificial reseeding on oak-brush range in central Utah. USDA Circ. 458. 1938.

II. Outside publications (in scientific and professional journals, etc.)

Craddock, George W. Keeping our wild-land soils in place. Jour. of Forestry, vol. 36, no. 9. 1938.

Maki, T. Ewald. The Intermountain forests. Southern Idaho Forester. 1938.

Saunderson, Mont H. Economic relationships of public lands and privately owned grazing lands in the western states. Jour. of Farm Economics, vol. XX, no. 4. 1938.

_____ Problems of economic research in the use and management of western grazing lands. Annual Proc. Western States Farm Economics Association. 1938.

_____ Land values and land charges for range livestock production. The National Woolgrower, vol. 28, no. 12. 1938.

Saunderson, Mont H. and T. Dean Phinney. The economics of early lamb production by farm flock operators. Utah Farmer, December 1938.

_____ and Roth, Arthur H. Jr. Financial results in fattening cattle. American Cattle Producer, vol. 20, no. 7, 1938.

Stewart, George. Revegetating man-made deserts. Jour. of Forestry, vol. 36, no. 9. 1938.

Stoddart, L. A., Lister, P. B., Stewart, George, Phinney, T. Dean and Larson, L. W. Range conditions in Uinta Basin, Utah. Utah Agri. Expt. Stat. Bull. 283. 1938.

Woodward, Lowell and Anderson, D. A. A device for the rapid collection of surface-inch soil samples. Jour. Amer. Soc. Agron. 30:2, 1938.

III. Miscellaneous mimeographed reports

Bailey, Reed W. Mountain waters. Address given at the Western Regional Farm Bureau Conference, held at Old Faithful Inn, Yellowstone National Park, 1938.

Cottam, W. P. and Stewart, George. Range conservation in Wasatch County, Utah. Cooperative Western Range Survey report. 1938.

_____ Range conservation in Gem County, Idaho. Cooperative Western Range Survey report. 1938.

Craddock, George W. Interim report, Willow Creek Work Unit, Boise River Watershed, Idaho. Flood Control Field Coordinating Committee 17C. 1938.

Hansen, J. Deloy and Clark, Ira. Tentative range utilization handbook. U. S. Forest Service, Region 4.

Hutchings, Selar S. Forage volume and proper use ratings of forage plants for winter grazing (Nov. 1 to April 15). 1938.

Maki, T. E. A method of determining maturity of ponderosa pine seed. (Mimeographed for regional distribution.) 1938.

Pearse, C. Kenneth, and Stewart, George. Suggestions for drilling grass seed on ranges with slopes steeper than 35 percent. Mimeo.

Pechanec, Joseph F. and Stewart, George. Program of field days June 9 and 10, 1938, held at U. S. Sheep Experiment Station.

Porter, W. D. Experiment station conducts field day. Utah Farmer, July 1938.

Saunderson, Mont H. Research problems in utilization of western range lands. Mimeo. 1938.

Stewart, George and Hull, A. C., Jr. Artificial reseeding instructions, 1938.

B. Departmental publications scheduled for the remainder of the fiscal year 1939.

Costello, D. F. and Price, Raymond. Weather and plant development in relation to range management. USDA Tech. Bull. GPO 2-24-39.

Stewart, George, Walker, R. H., and Price, Raymond. Procedure in reseeding. USDA Farmers' Bull. 1823. GPO 3-10-39.

C. Manuscripts intended for departmental publication during the fiscal year 1940.

Hutchings, Selar S., and Stewart, George. Palatability and utilization of desert vegetation as influenced by climate, season of use, and composition of plant cover. Jour. Agr. Research, 20 pp., 6 illus.

McCarty, E. C. and Price, Raymond. Growth and carbohydrate food ratios, etc. In process of editing WO. USDA Tech. Bull.

Maki, T. Ewald. Root development of ponderosa pine seedlings on the granitic soils of central Idaho. Jour. Agr. Research; 15 pp., 6 illus.

_____ Collection, extraction, and testing of ponderosa pine seed. Tech. Bull. 45 pp., 10 illus.

Mowat, Edwin L. Seed production by various sizes and classes of ponderosa pine trees in Idaho. Jour. Agr. Research; 12 pp., 5 illus.

Pechanec, Joseph F. and Stewart, George. Sampling problems on sagebrush-wheatgrass forage inventory. Jour. Agr. Research; 30 pp., 10 illus.

Plummer, Perry. Viability, rate of germination and early development of twelve important range grasses. Jour. Agr. Research. (Thesis under same title completed.) 5 pp., 1 illus.

Price, Raymond and _____. The relation of season, frequency, and degree of harvesting to the productivity, revegetation, and vigor of the vegetation. USDA Tech. Bull.

Stewart, George, Cottam, W. P. and Hutchings, Selar S. Plant associations and forage conditions, etc. Sent WO. Jour. Agr. Research. 20 pp., 12 illus.

_____ and Hull, A. C. Jr. Adaptation of forage species and their suitability for artificially reseeding on different range sites in Utah and Nevada. USDA Bull. 32 pp. 10 illus.

_____ Hull, A. C., Jr., and Pearse, C. Kenneth. Adaptation of forage species to various soils and moisture conditions and low cost methods for artificially reseeding range lands of the Intermountain region. USDA Bull. (32 pp., 12 illus.)

_____ and Hutchings, Selar S. Improvement of winter ranges as influenced by various intensities of grazing. USDA Bull. 32 pp., 10 illus.

_____, Pickford, G. D. and Pechanec, Joseph F. Effect of sagebrush removal by fire on native spring-fall range in southeastern Idaho. Edited in WO and returned for revision. Jour. Agr. Research, 30 pp., 12 illus.

D. Manuscripts and articles proposed for outside publication.

Bailey, Reed W. Northern Utah earthquake phenomena. Bull. Seismol. Soc. Amer.

_____ Mud-rock flow. Amer. Jour. Sci.

_____ Flood history of two streams, Wasatch Mountains, Utah. Jour. Geol.

_____ and Croft, A. R. Some social and economic aspects of northern Utah floods. Geog. Review.

Croft, A. R. and Woodward, Lowell. Range soil losses as a result of accelerated erosion. Jour. Amer. Soc. Agron.

_____, Woodward, Lowell and Anderson, D. A. Measurement of accelerated erosion on range watershed lands. Jour. Amer. Soc. Agron.

Harris, J. A. and Stewart, George. Plant sap properties and their relation to environmental conditions and to forage value. Ecology. 30 to 40 pp.

Hull, A. C., Jr., and Pearse, C. Kenneth. Annotated bibliography for reseeding. Mimeo.

_____ and Martin, Thomas L. A preliminary study of physical and chemical soil characteristics of desert soils under sagebrush, shadscale, and winterfat. To be published in Proc. Utah Acad. Sciences.

_____ and Shaw, Seth T. Respiration of Poa bulbosa. To be published in Proc. Utah Acad. of Sciences.

_____ and Stewart, George. Bulbous bluegrass on the foothill ranges of Utah. Probably Jour. Amer. Soc. Agron. 10 pp., 2 illus.

Hutchings, Selar S. New method of coordinate mapping of low shrubs. Jour. Amer. Soc. Agron. 6 pp., 3 illus.

Maki, T. Ewald. Significance and applicability of seed maturity indices for ponderosa pine. Jour. of Forestry.

_____ Man-caused fires -- an insolvable problem? American Forests.

_____ Behold our land, and To Hold this soil. Reviews for Jour. Forestry.

_____ Branching habit and rate of natural pruning in second growth ponderosa pine. Jour. Forestry.

_____ Cost of pruning as related to size of ponderosa pine trees. Timberman.

_____ and Mowat, Edwin L. Some physical and chemical characteristics of granitic soils in central Idaho. Soil Science.

Mowat, Edwin L. Results of selective cutting in ponderosa pine forests of central Idaho. Jour. Forestry.

_____ Damage to reserve stands and reproduction by logging and slash disposal in ponderosa pine of central Idaho. Jour. Forestry.

Pearse, C. Kenneth. Soil factors influencing the infiltration rate of range soils of the Intermountain region. Soil Science. Undergoing extensive revision as result of WO review.

Pechanec, Joseph F. Analysis of covariance in range research. Being revised.

_____ Effect of sagebrush fires on soil properties. Soil Science.

Saunderson, Mont H. A graphic summary of grazing on the public lands of the Intermountain region. Mimeo. 500 copies, general distrib.

_____ Economic aspects of size of livestock enterprises and the significance to public land grazing privileges. Mimeo. R-4 distrib. 250 copies.

_____ The prevailing land charges on the stock ranches of northeastern Utah. National Woolgrower.

_____ Economic aspects of trucking and trailing of livestock from range to shipping and marketing points. Amer. Cattle Producer.

_____ Flexible livestock operations and stable land use in the Northern Great Plains. Land Policy Review.

_____ A method for the analysis of the probable financial results of range improvement resulting from adjustments in the rate of use of range lands. American Forests.

Stewart, George and Young, A. E. The hazard of basing permanent grazing capacity on Bromus tectorum. Jour. Amer. Soc. Agron. 10 pp., 2 illus.

_____ and Hull, A. C., Jr. Grass reseeding on mountainous summer ranges and watersheds. American Forests. Illus. 12 typed pp.

Walker, R. H., Klingebiel, A. A., and Stewart, George. Intensity of nitrification in range soils of the Intermountain region. Soil Science.

STATION PERSONNEL - C.Y. 1938

ADMINISTRATION

Regular

Reed W. Bailey	Director
Walter E. Mann	Adm. Assistant
Marguerite A. Israelson	Clerk
Herbert Burrell	Clerk
Leona H. O'Donnell	Asst. Clerk
Hazel Brown	Sr. Stenographer
Signe Ruh Otterson	Jr. Librarian (Coop. R-4)

Temporary

Zura Gerdicia	Sr. Stenographer
Buster Williams	Under Clerk
Henry A. Ward	Under Clerk

RANGE INVESTIGATIONS

Grazing Management

Regular

George Stewart	Sr. Forest Ecologist
Lincoln Ellison	Range Examiner
Joseph F. Pechanec	Assoc. Forest Ecologist
Selar S. Hutchings	Asst. Forest Ecologist
Ira Clark	Asst. Conservationist

Temporary

Harold E. Gibson	Jr. Field Assistant
C. Ralph Stocking	Asst. Field Asst.
John W. Quayle	Jr. Field Assistant
Eldon Earl Meik	Under Field Assistant
Paul E. Hansen	Jr. Field Assistant
Richard Hougland	Under Field Assistant

Artificial Reseeding

Regular

C. Kenneth Pearse	Conservationist
Alvin C. Hull	Jr. Range Examiner

Temporary

Henry E. Peterson	Asst. to Technician
Albert A. Klingebiel	Jr. Field Assistant
Gerard J. Klomp	Jr. Field Assistant
Perry Plummer	Jr. Range Examiner

FOREST ECONOMICS

Range Economics

Regular

Mont H. Saunderson	Sr. Economist

Temporary

Howard B. Passey	Jr. Range Examiner
Robert S. Blakeley	Under Field Assistant
Oliver Cliff	Under Field Assistant
Harold Cooper	Under Field Assistant
Frederick B. Harris	Under Field Assistant
Harold W. Hirst	Asst. Field Assistant
Clair O. Lund	Under Field Assistant
Justin M. Smith	Under Field Assistant

FOREST MANAGEMENT RESEARCH

Silviculture

Regular

T. Ewald Maki	Assoc. Forester
Edwin L. Mowat	Asst. Silviculturist

Temporary

Maurice C. Yearsley	Jr. Field Assistant
Edmund L. Barraclough	Minor Asst. to Technician

FOREST AND RANGE INFLUENCES

Influence of Natural Vegetation on Stream Flow

Regular

George W. Craddock	Sr. Range Examiner
A. Russell Croft	Assoc. Conservationist
Lowell Woodward	Jr. Range Examiner

Temporary

Maurice W. March	Jr. Range Examiner
Howard E. Petersen	Jr. Range Examiner
Howard R. Foulger	Asst. Field Assistant
Abram Riggs Murdock	Asst. Technician
Grant Harris	Jr. Field Assistant
William S. Heitz	Jr. Field Assistant
Harry W. Pledger	Foreman C&M
Dean R. Purrington	Under Field Assistant

FLOOD CONTROL SURVEYS

Preliminary Examinations

Regular

Reed W. Bailey		Director
George W. Craddock		Sr. Range Examiner

Temporary

Howard E. Petersen		Jr. Civil Engineer

Boise River Survey

Regular

Reed W. Bailey		Director
George W. Craddock		Sr. Range Examiner
Thomas H. Van Meter		Forester
Kenneth M. Daniels		Forest Ranger
McKinley Jackson	(Coop. S.C.S.)	
Verne H. Eliason	(Coop. B.A.E.)	
Fred E. Schlots	(Coop. S.C.S.)	
Edwin O. Nurmi	(Coop. S.C.S.)	

Temporary

Percy R. Andros	Field Assistant
Byron F. Thurmond	Surveyor Draftsman
John E. Moats	Jr. Field Assistant
Keith M. Walker	Asst. Clerk
George L. Ballinger	Asst. Draftsman
John H. Malmstrom	Under Field Assistant
Dudley Munns	Under Field Assistant

WORK PLANS FOR STUDIES

FOREST MANAGEMENT RESEARCH

I. Silviculture

a. Methods of cutting ponderosa pine. (Memorandum of procedure) (Connaughton, Mowat)

b. Study of cut-over areas in central Idaho. (Memorandum of procedure) (Connaughton, Mowat)

c. Delayed effects of fire on mortality and growth of ponderosa pine. (Memorandum of procedure) (Connaughton)

d. Timber stand improvement. (Memorandum of procedure) (Connaughton, Pender)

e. Natural reproduction of ponderosa pine. (Mowat)

f. Seed yield and quality from different sizes and classes of ponderosa pine trees. (Mowat)

g. The role of plant competition in natural reproduction of ponderosa pine. (Mowat)

h. Branching habit and rate of natural pruning in second growth ponderosa pine. (Maki)

i. Cost of pruning second growth ponderosa pine as related to size of tree and type of tool. (Maki)

j. Rate of healing of limb scars in relation to size of branch, age of tree, and aspect. (Maki)

II. Regeneration

a. The Boise Basin burn planting "project." (Mowat)

b. Root studies. (Connaughton)

c. The effect of depth of planting on survival of different classes of ponderosa pine nursery stock. (Maki)

d. Effect of different methods of planting on survival and growth of three grades of ponderosa pine planting stock. (Maki)

e. The effect of method of planting on survival and growth of different grades of ponderosa pine and Douglas fir on several aspects. (Maki)

f. The influence of partial reduction of competition by burning on survival and growth of ponderosa pine. (Maki)

g. Survival and growth of ponderosa pine nursery seedlings in relation to degree of root pruning. (Maki)

h. The influence of degree of surface scalping and time of removal of screen cones on losses in ponderosa pine spot seedings. (Maki)

i. A direct comparison of planting and spot seeding. (Maki)

j. Efficiency of different types of planting tools with reference to initial survival and growth of ponderosa pine seedlings on granitic soils. (Maki)

k. Influence of time of planting on survival of different grades of ponderosa pine. (Maki, Mowat)

l. Comparison of root development of field planted ponderosa pine seedlings. (Maki)

m. Specific gravity of freshly picked ponderosa pine cones as an index of seed maturity. (Maki)

n. The effect of different temperatures and duration of storage on viability of ponderosa pine seed. (Maki)

o. The influence of storage temperatures and soaking treatments on germinative energy of ponderosa pine seed. (Maki)

RANGE RESEARCH

I. Grazing Management

Spring-Fall Ranges, U. S. Sheep Experiment Station

a. Effect of climate on forage production. (Pechanec)

b. Rotation of spring grazing use. (Pechanec)

c. Intensity of spring grazing use. (Pechanec)

d. Use of fire in range management. (Pechanec)

Fremont County Burning Project

Field work will be discontinued in 1939.

Utah Sagebrush-grass spring-fall range studies

Areas to be rechecked in 1942.

II. Artificial Reseeding

(Prepared by Pearse, Hull, Plummer, and Peterson)

Note: More than 50 detailed individual study work plans have been completed by staff members of this project during the past year. For the purposes of these reports these have been grouped as follows:

a. Adaptability of species for reseeding on the granitic soils of the Boise River watershed (3 studies).

b. Adaptability of species for reseeding on the sagebrush areas near Wells, Nevada (4 studies).

c. Adaptability of species for reseeding on the sagebrush areas near Paradise Valley, Nevada (5 studies).

d. Adaptability of species for reseeding on the desert ranges near Milford, Utah (8 studies).

e. Adaptability of species for reseeding on spring-fall ranges near Dubois, Idaho (1 study).

f. Adaptability of species for reseeding on spring-fall and summer ranges on the Wasatch Front in Utah (8 studies).

g. Adaptability of species for reseeding on spring-fall and summer ranges near Great Basin Branch Station, Utah (6 studies).

h. Adaptability of species for reseeding on spring-fall and summer ranges near Kemmerer, Wyoming (2 studies).

i. The use of hormone and Vitamin B_1 for promoting the rooting of cuttings (2 studies).

j. The use of transplants for revegetating denuded range lands in the Intermountain region (3 studies).

k. Studies on the rate, season, and depth of planting Agropyron cristatum and Bromus inermis on ranges where these species are adapted in the Intermountain region (5 studies).

l. Effect of nitrogen and phosporus carrying fertilizers on forage yield of established stand of Bromus inermis and Poa pratensis (1 study).

RANGE ECONOMICS

a. An economic study of the relation of the public lands to the livestock enterprises of the farms and ranches for an area in south central Utah consisting of Millard, Beaver, Sanpete, Sevier, Carbon, Emery, and Piute Counties. (Saunderson)

b. A statistical analysis of the National Forest and Division of Grazing permits of Region 4. (Submitted as a proposal for the use of WPA "white collar" help.) (Saunderson)

c. An economic analysis of the land charge on the privately owned lands of national forest permittee stock ranches in northeastern Utah. (Saunderson)

FOREST AND RANGE INFLUENCES

I. Influence of natural vegetation on stream flow: Forest.

a. A study of altitude and aspect in relation to water yield from Parrish Creek and from Centerville Creek watersheds in northern Utah. (Croft)

Influence of natural vegetation on stream flow: Chaparral.

b. The effect of controlled grazing upon surface run-off and erosion within the Transition and Canadian zones of the Wasatch front in central Utah. (Croft)

c. A study of the effect of contour-trenches on soil moisture content and seedling survival. (Croft)

Influence of natural vegetation on stream flow: Woodland cover.

d. The effect of plant cover type and density on run-off and erosion in the Canadian zone of the Wasatch Mountain front in northern Utah. (Croft)

e. A study of water-measuring devices for steep mountain streams. (Croft)

Influence of natural vegetation on stream flow: Grassland.

f. A study of the influence of herbaceous plant cover on the surface run-off and soil erosion in relation to grazing on the Wasatch Plateau in Utah. (Croft)

g. A study of artificial seeding in relation to surficial run-off and erosion on foothill lands of the Wasatch Mountain front in northern Utah (cooperation with Artificial Reseeding project). (Croft)

h. Wood Creek triplicate drainages work plan. (Woodward)

i. Bannock Creek areas A & B work plans. (Woodward)

II. Water utilization by vegetation: Range forage.

j. Lysimeter investigations. (Woodward)

Water utilization by vegetation: Tree species.

k. A study of the effect of contour-trenches on soil moisture content and seedling survival. (Croft)

III. Stabilization of soils: Watersheds

l. A study of soil changes in relation to accelerated erosion in the mountain brush zone of the Wasatch Mountain front. (Croft)

m. A study of soil changes in relation to accelerated erosion on three watersheds near Salt Lake City, Utah. (Croft)

n. A study of minimum contour-trench standards for controlling run-off and erosion on the foothill lands of the Wasatch Mountain front. (Croft)

IV. Effect of cover on climate: Forests

o. A study of the micro-climate on contrasting aspects in Ogden Canyon, Utah. (Croft)

p. A study of the character and distribution of precipitation on the Davis County watershed in relation to flood occurrence. (Croft)